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The Welding Engineer

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...e XXI | September, 1936 | Number 9

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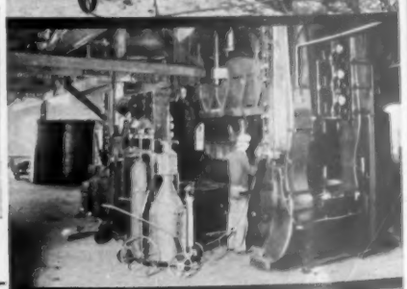

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THE WELDING ENGINEER

Vol. 21, No. 9 SEPTEMBER, 1936

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EDITORIAL

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Training Welders for Industry

● A considerable number of large fabricators who heretofore have depended on the employment market for welding operators are now either engaged in training men to handle welding or are seriously contemplating such a move.

There is a decided scarcity of operators, but in all cases this is not the only reason—and perhaps not the main one—back of this trend toward industrial-plant training.

The scarcity of operators may not be apparent to plants whose operations are not subject to wide fluctuations, nor may operators themselves be aware of it. But it becomes real whenever operators are wanted in considerable numbers, and becomes pathetic when projects requiring considerable welding for their fruition have to be abandoned altogether or modified because of the inability to obtain good men in the numbers desired. This very thing has happened in several instances since the first of the year.

A factor instigating the training of operators in some of the large plants is the feeling that certain specialized knowledge is required for the work on hand—knowledge of the kind that is not obtained on routine welding, nor even in special welding operations.

For example, one of the country's largest fabricators are taking young machinists and others from various departments of their plants and giving them intensive training in the reading of blueprints, setting up work, estimating allowances for contraction, handling the electrode and the torch, cleaning the welds, and checking the job.

This plant has rejected many applicants who have good records as welding operators on so-called Class 1 pressure vessels. This is not surprising when one realizes that oftentimes a first-class operator's work is set up for him and consists entirely of welding in the down-hand position with heavy-coated electrodes of specified type and size, with the welding machine preset for voltage and current. This operator's welds are excellent; but put the man on a complicated assembly, leaving it to his judgment to select the welding sequence, size of electrode, machine setting, and he may not fare as well as a student of a few weeks' training.

Then, there is the plant which employs welders in bargain lots when a big order comes in, and discharges them when the order is completed, hoping that they will be waiting at the door of the shop when they are needed again. One plant of this description is training young men living in its immediate neighborhood, expecting thereby that in slack periods these men will be less likely to be weaned away by other plants, or at least will return when called back, in view of the advantages of having employment close to home.

These and many other factors enter the problem of whether a plant should train their own operators or employ them from the outside. But training implies the giving of good instruction—and competent welding instructors are not easily found.

If there is a solution to the problem of obtaining skilled help when needed, it is not immediately apparent. However, the matter deserves deep thought on the part of schools, vocational groups, and industrial and technical organizations.

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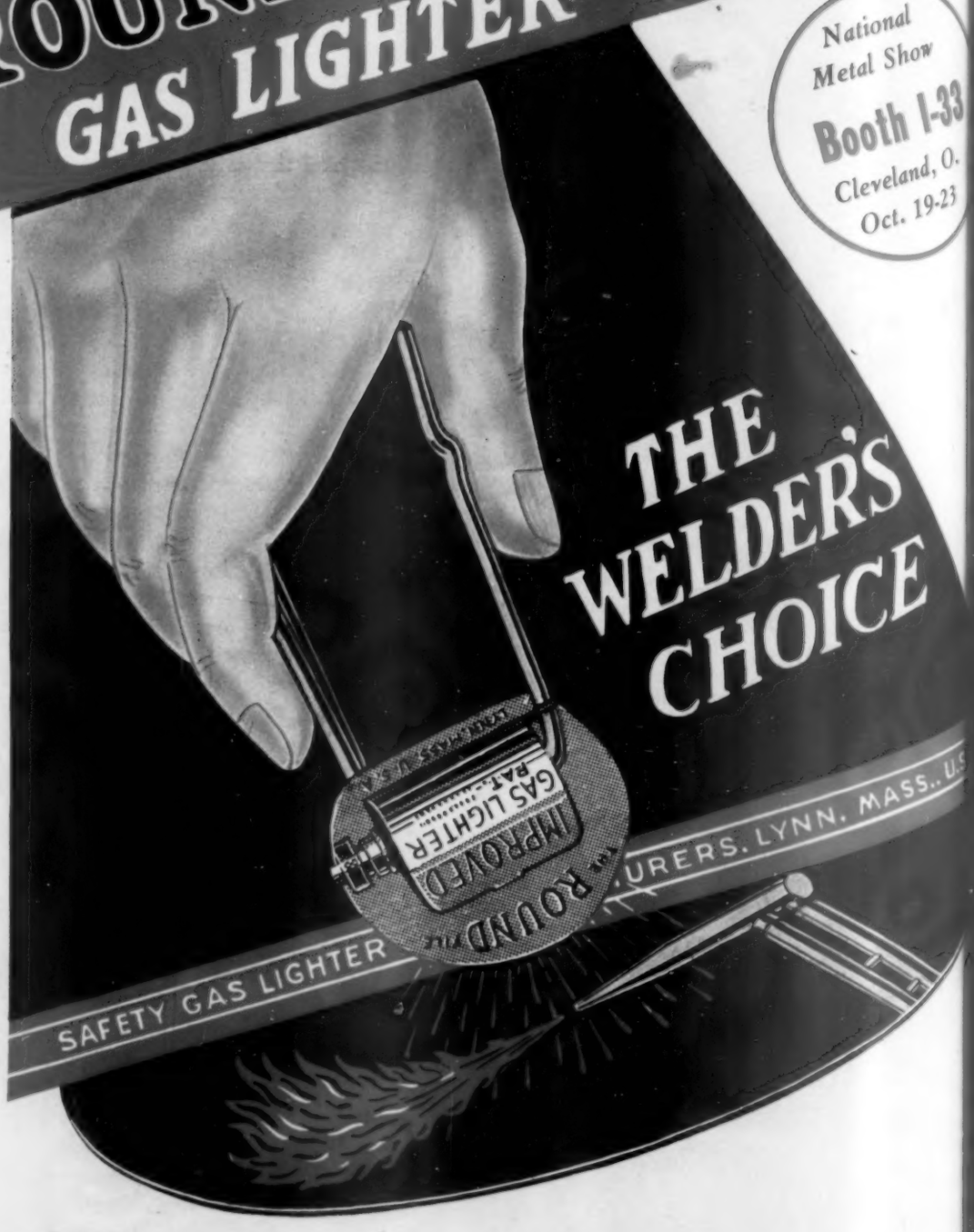

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The Welding Engineer

VOLUME XXI | SEPTEMBER, 1936 | NUMBER 9

Adding Nickel and Reducing the Carbon Content of the Casting Results in

Eliminating Brittleness *in* Manganese-Steel Welding . . .

AUSTENITIC manganese steel, containing 10-14% manganese (named Hadfield's steel, from its discoverer) has certain desirable properties that have made it an important product of the modern foundry. But the welding of this steel, owing to the damage of the parent metal near the weld caused by the welding heat, did not meet with any degree of success until the development in 1931 of the nickel-manganese welding electrode.

By using the nickel-manganese electrode with reasonable care, taking particular pains that the heat was not applied in any one spot so long as to induce serious carbide formations in the parent metal near the weld, it was possible to obtain welds of considerable strength, having similar physical properties to those of the parent metal, without brittleness. This method was limited to the metallic arc process, while carbon-arc and flame welding were strictly taboo.

Addition of Nickel Allows Reduction in Carbon Content

By adding nickel to austenitic manganese steel, it has been found that the carbon can be reduced, and the steel still retains its austenitic structure. This reduces the tendency for carbide formation along the critical-heat line when welding heat is applied, and seems to offer a final solution to the problem of fusion welding of this steel.

To test out this theory, castings of a nickel-manganese steel of austenitic structure have been made by the Pettibone Mulliken Co., 4710 W. Division St., Chicago, these having the following analysis and physical properties in the heat-treated condition:

OF ESPECIAL interest to the welding field is this announcement of a nickel-manganese steel with physical properties similar to Hadfield's steel but having, in addition, desirable welding properties.

CHEMICAL ANALYSIS

Carbon	0.60-0.90
Manganese	11.00-13.50
Nickel	2.5-3.5
Silicon	0.60-0.85

PROPERTIES

Tensile strength	155,500 lb. per sq. in.
Yield point	60,000 lb. per sq. in.
Elongation in 2 in.	55%
Reduction in area	36.6%
Brinell hardness number	196

After heating to 1150-1200°F. for three hours, a microscopic examination revealed no normal carbide precipitation. Welds made with both the arc and flame processes have shown no tendency to produce brittleness in the parent metal near the weld, and the elongation of the metal below the weld is not reduced below 30%, it is claimed.

No Precaution Taken to Keep Parent Metal Cool During Welding

In welding with either process, no precaution was taken to keep the parent metal cool. There was no skipping about while welding, and the heat was put into the metal as rapidly as required to make the deposit and obtain good fusion. Peening was done while the weld was hot, the same as when welding Hadfield's steel.

The table of properties of this steel shows an elongation in 2 in. by 55%, which is considerably greater than that obtained with Hadfield's steel. A further interesting fact is that the nickel-manganese steel attains its hardness more quickly while being worked, and hence its wear is less to obtain any degree of hardness necessary to meet the conditions of service. In a test made on a casting after heat-treatment, the sample was pounded with an air hammer, and 370 Brinell was reached when the surface was compacted down only 3/32 in.

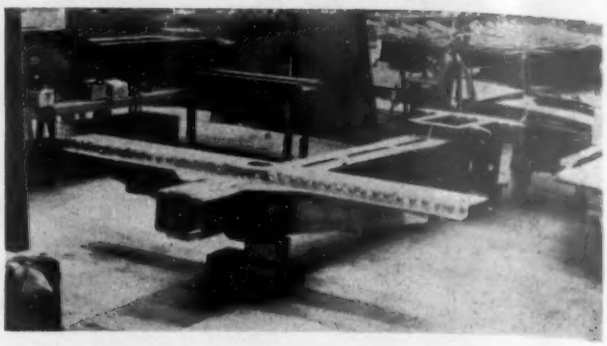
Nickel-Manganese-Steel Frogs Stand Up Well in Service

Two railroad frogs have been in service for more than two years in the Galewood yards, in Chicago, of the Chicago, Milwaukee & St. Paul Railroad, these frogs being located in the two front turnouts in the lead of the yard, where the most severe service is encountered. Recent inspection revealed the frogs to be in excellent condition and showing a surprisingly small amount of surface wear.

This nickel-manganese steel has been used for a number of years in the form of forged applicator bars of various shapes and sizes for welding onto worn shovel and dipper teeth, for repairing crusher plates and bucket lips, for building up worn manganese frogs and crossings, etc. The application of this steel in the form of castings is more recent, however. One of the railroad frogs mentioned is soon to be welded with the oxy-acetylene process in order to give the weld a test under the most severe conditions of service.

Milwaukee Road Builds All-Welded Rolling Stock of Low-Alloy Steel . . .

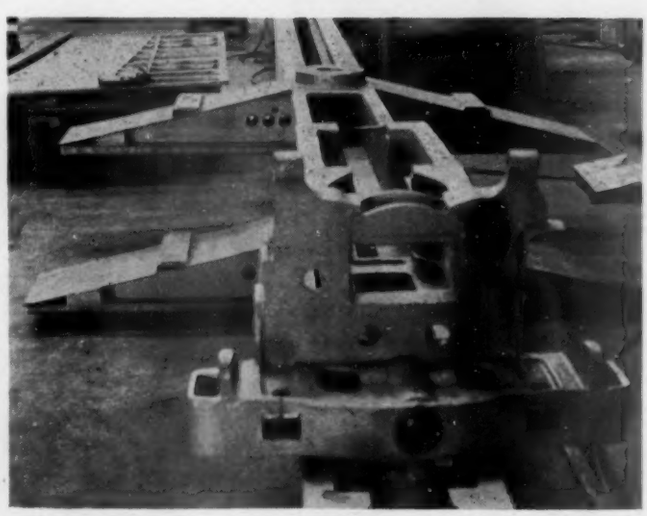
NEW coaches will show a substantial weight saving over the all-welded 1934 coach developed and built by the same road. Buckling of the side wall sheets, once a perplexing problem, has virtually been eliminated in the new design.



Assembly of Bolster to End Casting.
(All bolsters are made of plates assembled by welding.)

THE Chicago, Milwaukee, St. Paul & Pacific Railroad is constructing a total of 37 passenger cars of all-welded construction in its shops in Milwaukee, the work being undertaken under the direction of K. F. Nystrom, superintendent of the Car Department. These comprise 17 coaches, 4 parlor cars (2 of these will have staterooms), 2 tap-room cars, 2 beaver-tail cars, 2 diners, 5 baggage cars, and 5 combination mail-and-express cars. All sections and sheets used in the construction of these cars are of Cor-Ten, a high-tensile-strength alloy.

In 1934, 75 passenger cars were built in the same shops, these also being of all-welded construction, but ordinary carbon-steel sheets were used. The new coaches, employing Cor-Ten, will weigh approximately 90,000 lb. each, compared with 112,000 lb. for the 1934 welded coach and 150,000 lb. for the old-style passenger coach. The new coaches are about 80 ft. long, which is approximately the same length as the 1934 coach.



The End-Casting Assembly Is Welded and Riveted to the Center Sills.
(The center sill, only the end of which is visible in the back of the picture, consists of two wide-flange I-beams.)

View of Floor Assembly (on Left) and Side-Wall Assembly (in Back).

(In making the floor assembly, the floor-pans and side sills are lined up in a jig, and the pans are clamped and bolted, then spot welded together and tack welded to the side sills, after which the assembly is turned over and all transverse seams welded with the automatic carbon arc. Each section of the side-wall assembly consists of a letter-board sheet and lower side sheet, separated by three intermediate sheets for window spacers, where required, all tack welded together and the entire assembly spot welded in a series welder.)

Line Production Methods Used in Assembly

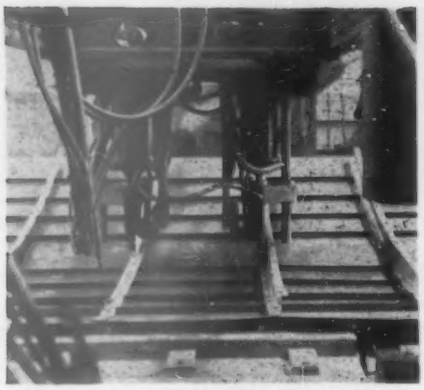
All cars are being made by line production methods. The underframe, floor pans, side walls, and roof are assembled in complete units. The floor-pan assembly is mounted onto the underframe, and then the two side walls are added, braces being used to hold them in position, after which the ends of the car and finally the roof is added. The complete assembly is then picked up and set upon temporary shop trucks.

In the assembly of the underframe, the bolsters are welded to the end casting, after which the assembly is welded and riveted to center sills, these consisting of two 10¼-in., 29-lb. wide-flange I-beams, made of Cor-Ten, running the length of the car. The bolsters, formerly of cast steel, are now made of plates assembled by welding.

The initial operation in making the floor assembly is to line up the side sills, which are Z-bars, in a large jig. The floor-pans, formed to proper shape from

Spot Welding Carlines Onto the Roof Sheets.

(The flat sheet has stiffeners welded in place. The carlines are tack welded to the sheet at about in their center, then fed through the series spot welder.)



At Each Operation the Two Electrodes Make Simultaneous Welds on Two Adjacent Carlines.

3/32-in. sheet, are then laid in place and clamped together with special fit-up bolts, after which they are resistance spot welded together on their outstanding legs, and then tack welded to the side sills. The entire floor assembly is then turned over and the pans are welded along all transverse seams with the automatic carbon arc, using a filler rod of washed wire, fed from a spool, and an autogenizer. A flux is brushed lightly over the seams before welding. Finally, the pans are hand welded to the side sills with continuous beads.

Minimum Radius Specified in Forming Sheets

In forming sheets for the floor-pans, roof sections, and other parts of the cars, care was taken that the forming radius not be less than 1½ times the sheet thickness, as sharper radii sometimes result in the formation of small cracks.

All floor-pans are uniform as to dimension and form, except that wherever necessary a section of the pans is cut out with a torch to allow space for *the* bolsters and end castings, consisting of coupler yoke, draft gear, etc.

Stifferens and Auxiliary Angles are Welded to the Side Plates in Special Jigs.

The next operation is the laying of the center-sill, end-casting and bolster assembly onto the floor-pans, after which both assemblies are joined together by means of intermittent welds along the flanges of the center sill. The bolsters are welded to the pans with a continuous weld, in which the step-back method is employed. With the complete underframe assembly in this upside-down position, the air-conditioning refrigerating unit, battery box, piping, water tanks, air reservoirs and electric conduits are placed on the assembly. This equipment is then completely enclosed with a shroud of sheet metal, which is also welded, except in those places where access to the enclosed equipment is desired, and there the sheets are mounted to the frame-work by means of screws.

Complete Roof Assembly.

(After the roof sections and side plates are assembled in a jig and welded, the entire assembly is turned over and continuous welds are laid underneath. The ridge pole also is welded in place and the air-conditioning unit is attached to the roof.)

Side Walls Are Assembled in One Piece and Erected In Place

Next, the couplers, draft gears, etc., are put in place. The entire frame assembly, which now weighs 22,820 lb., is then turned over and moved further along the production line. The next operation is the erection of the sides.

In the meantime, the two sides and roof have been assembled and are delivered complete, ready for erection.

Both side walls are made up of sections 10 ft. 4½ in. long, each consisting of a letter-board sheet and a lower side sheet, both of which extend the length

THE views on this page show, first, the roof ready for the final car assembly; next, laying the underframe onto the floor assembly; then, moving the welded underframe and floor assembly further along the production line; and finally, the addition of the air-conditioning refrigerating unit, battery box, piping, water tanks, etc., also couplers and draft gears.

of the section and are separated by intermediate sheets or window spacers in coaches, diners and parlor cars. All sheets are cut and formed to proper shape from 14-gauge material. Rigidity is added by resistance spot welding angle stiffeners to the sheets.

All sheets making up a whole side are laid out in a jig. The intermediate sheets are tack welded to the letter board and lower side sheet, the side posts are tack welded in place, and a side-plate angle is plug welded along the entire top edge of the letter board. (Upon assembly of the sides and roof, this side-plate angle is welded to an auxiliary side-plate angle along the edge of the roof assembly.) The entire side assembly is then fed through a series welder (a spot welder producing two spots per operation).

In the completed side wall, the side posts are in pairs with center-to-center separation of 13 in., generally, and a separation of 2 ft. 4½ in. between posts of adjacent pairs, thus allowing spaces of approximately 2 ft. 4 in. in length for window openings, where these are required.

With this type of construction, the only continuous-bead welding employed on the side walls are the vertical welds along the edges of the 10-ft. 4½-in. sections, and the short horizontal welds at the top and bottom of the intermediate sheets, made after the entire car assembly is completed. Hence, distortion due to welding heat in the side-wall sheets is virtually eliminated, whereas in the 1934 coach the problem of distortion was a difficult one.

Roof Plates, Stiffeners and Carlines Form the Roof Sections

The roof sections also are 10 ft. 4½ in. long, made of 1/16-in. sheet. Stiffeners are welded in place on the flat sheet, after which the carlines, which are Z-sections, bent to the correct roof curvature, are located in their proper spacing on the roof sheet by tack welding at their centers.

The sheets, with carlines, are then moved to the series welder, where the carlines are spot welded to the sheet. One of the welding electrodes makes a spot in one carline and the other electrode makes a spot simultaneously in an adjacent carline. In this operation, the roof sheets are bent to conform to the contour of the carlines. The side plates,

which connect the roof sheets to the letter-board sheets of the side walls, are are welded to Z-section stiffeners in a special jig, after which the auxiliary side-plate angle is welded to the assembly.

The roof sections and side plates are assembled in a jig, and then welded to make a complete roof, after which the entire assembly is turned over and continuous welds laid underneath to join all sections while in the inverted position.

The ridge pole, which is also a Z-section, is then welded to the roof assembly, and the air-conditioning unit, which is supported from the roof, is attached.

After the side walls are erected on the underframe assembly, and before the roof is put on, the car ends are put in place. These are assembled in a jig, half of an end at a time, each half consisting of a plate with upright I-beams and stiffeners, all welded together. In the final assembly, the lower part of the I-beams are welded to the end casting.

The roof is then put on, together with the end-plate channels, and tack welded in place, after which the end-plate channels are welded in place and to the top of the I-beams in the car-end assembly. Bulkhead sheets are subsequently applied, closing the opening under the roof.

Turning Over Floor and Underframe Assembly, Onto Which the Side Walls Will Be Erected.

With the Side Walls and Car Ends in Place, the Roof Is Put On.

All Outside Seams Welded With Continuous Beads

The car is then inspected and any slight irregularities that might be found are corrected, after which all seams on the outside of the car are welded with continuous beads and any excess weld metal is ground off to give a smooth appearance. The outside of the car is then given several coats of primer, enamel and varnish.

The car is then ready for final assembly and application of insulation, air ducts and interior finish. Trucks, previously assembled, replace the shop trucks and complete the car.

All vestibules are provided with welded folding steps.

In the design of the car, a shrinkage of 0.010 in. per foot was allowed along the length of the body. This allowance was determined by means of a test made with Cor-Ten sheets, formed in angular shape, which revealed a shrinkage of 0.0108 in. per foot. Using this figure, one finds that the shortening of the 80-ft. underframe Cor-Ten side still would be 0.8640 in. This is in agreement with the result of measurements taken on several underframes before and after welding, these measurements recording shrinkage from $\frac{5}{8}$ to $\frac{7}{8}$ in.

Interior View of Coach, Ready for Insulation and Air Ducts.

Correction on Joint Factor for Welded Storage Tanks

The new API tentative specifications for all-welded oil storage tanks gives a joint factor of $0.5+k/5$, which is a correction of the report in the August issue of *The Welding Engineer*, in which the plus sign was inadvertently omitted. This factor is applied to vertical lapped joints where a full-fillet lap weld is on the outside and the inside weld is at least 25% intermittent, and k represents the percentage of full-fillet intermittent welding, expressed as a decimal.

This aerial view of downtown Cleveland clearly shows the Terminal Tower alongside of which is Hotel Cleveland, where the American Welding Society meetings are to be held. The Public Auditorium, where the Metal Exposition will hold forth, is a little left of the center of the picture.

Cleveland to be Host to Welding and Metal Groups . . . .

THE big welding event of the year takes place in Cleveland, O., on Oct. 19-23, when the American Welding Society, together with the American Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers, and The Wire Association, gather to review developments in the many branches relating to the making, forming, treating and fabrication of steel and other metals and alloys.

This marks the annual fall meeting of the American Welding Society, and at this time will be held the annual business meeting of the Society. The holding of the annual meeting at this time is the result of a recent change in the Society's constitution changing the date of the annual meeting from the spring of the year to the fall.

Concurrently with the technical sessions of the various participating societies, there will be held the National Metal Exposition, which will occupy four acres of floor space in the Cleveland Public Auditorium, with more than 200 manufacturers represented with displays and working exhibits.

The American Welding Society will hold its meetings in the Ball Room of the Hotel Cleveland. The annual business meeting will be held Monday morning, beginning at 9:45 o'clock, at which the awarding of the Samuel Wylie Miller Memorial Medal will be made, the tellers will make their report on the election of officers, and President Crowe will give his report.

The Thursday morning and afternoon sessions will be held jointly with the American Society of Mechanical Engineers. No technical sessions are scheduled on Friday, but the American Welding Society members are invited to attend the A. S. M. E. sessions on that day, all papers being devoted to topics of particular interest to the welding field.

The annual banquet and dance will take place on Thursday evening, with Dr. W. E. Wickenden, president of the Case School of Applied Science, as the chief speaker.

A "stag" with entertainment is scheduled for Wednesday night, beginning at 10 o'clock in the Alpine Village on the exposition grounds.

Special entertainment throughout the week has been prepared for the ladies, the details of which are given on another page. A committee is preparing inspection trips to various Cleveland fabricating plants.

Exhibits and demonstrations of equipment and supplies used in welding and cutting and related fields, as reported by the various exhibitors, are described on the opposite page.

Union Terminal and Hotel Cleveland, With Public Square in Foreground.

Exhibits Relating to Welding and Allied Fields

Air Reduction Sales Co., New York, N. Y. Booth G-7.

Various styles in oxyacetylene cutting machines, also portable motor-propelled hand-guided machine, will be in operation, as well as a machine for cutting off and beveling pipe. A portable tensile and bend testing machine will be demonstrated, using weld specimens. Other demonstrations will include arc welding, brazing of bronze and brass pipe fittings, hard-surfacing, and gas welding and cutting. A wide variety of welding and cutting equipment and accessories will be on display.

In attendance: C. D'W. Gibson, J. F. Pryor, H. W. Reade, H. L. Rogers, G. VanAlstyne, Dr. G. V. Slottman, J. J. Crowe, H. F. Henriques, J. M. Driscoll, J. F. Callahan, R. F. Helmkamp, A. N. Kugler, V. Forgett, A. H. Yoch, Don Llewellyn, H. O. Jones, G. Munson and R. Fisher.

American Brass Co., Waterbury, Conn. Booth C-21.

High-strength copper alloys in commercial and fabricated forms will be exhibited. Demonstrations will be given with all types of welding with bronze rods, including the long-arc high-voltage welding of copper.

In attendance: W. C. Swift, C. E. Swift, and representatives from Cleveland office.

American Steel & Wire Co., Cleveland, O. Booth C-15.

Demonstrations in arc welding of stainless and heat-resisting alloys, also carbon steels.

In attendance: Fred Connell, New York; John Graham, New York; H. C. Pearson, Boston; F. O. Howard, Buffalo; C. J. McGregor, Chicago, and the following Cleveland representatives: V. H. Heimberger, R. C. Pierce and Paul Ketring.

Bastian-Blessing Co., Chicago, Ill. Booth L-19.

Exhibiting oxyacetylene welding and cutting equipment, torches, regulators, manifolds, etc., also liquefied-petroleum regulators, manifolds and special valves. Continuous demonstration of an efficient gas-cutting operation with prize offered each day for closest estimate of oxygen consumed. Additional demonstrations of hand-welding and cutting operations.

In attendance: E. L. Mills, vice-president and sales manager; E. M. Evleth, engineer; H. A. Goodwin, district sales manager, and H. O. T. Ridlon, district sales manager.

Colmonoy Co., Los Nietos, Calif. Booth N-46.

Exhibiting fabricated products and welded-on overlays, including metallic-boride-crystal overlays. Actual demonstration of furnace application of surfacing products to steels of different analyses.

In attendance: Miles C. Smith, sales manager, and Thomas Norden.

General Electric Co., Schenectady, N. Y. Booth E-23.

Controlled-atmosphere mesh-belt brazing furnace in operation, with regular production runs of many types of intricate assemblies. In addition, portable motor-generator welders, welding transformers and a gasoline-driven portable welding generator will be in operation, using different types and sizes of electrodes.

In attendance: H. M. Webber, A. N. Otis, O. A. Tilton and Cleveland representatives.

General Electric X-Ray Corp., Chicago, Ill. Booth E-21.

Exhibiting X-ray spectrograph and industrial X-ray apparatus.

In attendance: E. W. Page, manager, industrial division; H. Trenary and R. Dent.

Handy & Harman, New York, N. Y. Booth D-27.

Featuring low-temperature brazing alloys, silver solders and brazing flux. Demonstration of oxyacetylene brazing of ferrous and non-ferrous metals, and electric-resistance brazing and dip-brazing. Samples of work will be exhibited, and silver-clad metals and silver contact metals will be displayed.

In attendance: F. T. Van Syckel, Leo Edelson, John Gunther, Herman Folgner and A. W. Swift.

Harnischfeger Corp., Milwaukee, Wis. Booth L-54.

Demonstrating full-automatic welding with coated rod under production conditions, rod changes being made automatically without shut-downs. Arc-welding machines, coated welding rod, electric motors and electric hoists will be shown.

In attendance: G. L. Drake, L. F. Vonier, W. Oesterlein, A. D. Bullerjahn, A. Huennekens and K. L. Hansen.

Haynes Stellite Co., Kokomo, Ind. Booth O-30.

Demonstration of cutting a steel billet with a tool kept at red heat. Metal-cutting tools will be exhibited, together with castings and applications of hard-facing.

Hobart Brothers, Troy, O. Booth B-15.

Exhibiting 40-volt arc welders. Demonstrations of arc welding on ferrous and non-ferrous metals, including light-gauge sheets and heavy sections. Display of photographic panels showing typical welding applications.

In attendance: E. A. Hobart, president; W. H. Hobart, vice-president; W. J. Chaffee, welder sales; E. K. Butterfield, welder sales; E. C. Galbreath, general manager; O. H. Menke, superintendent, and Russel Flory, chief engineer.

Hollup Corporation, Chicago, Ill. Booth A-15.

Working demonstration of the welding of ferrous and non-ferrous metals.

In attendance: O. W. Howland, sales manager; A. M. Candy, consulting engineer; R. D. Long, metallurgist, and the following service engineers: R. C. Bender, H. F. Zeigler, H. N. Hester, G. O. Rohder, R. P. Monroe, R. C. Barr; also representatives from Cleveland office.

International Nickel Co., Inc., New York, N. Y. Booth B-7.

Displaying ferrous and non-ferrous applications of nickel, and applications of nickel alloys used in communication, transportation, general industry and road-building and construction equipment.

In attendance: T. H. Wickenden, H. L. Geiger, N. P. Pilling, E. M. Wise, E. J. Hergenroether, D. A. Nemser, J. W. Sands, R. A. Wheeler, G. Geiger, H. E. Searle, C. J. Schrefer, E. A. Turner and C. McKnight.

Linde Air Products Co., New York, N. Y. Booth O-30.

An oxyacetylene shape-cutting machine will be in operation, and acetylene generators, gas regulators, and cutting and welding torches will be displayed. Oxyacetylene welding will be demonstrated.

Lincoln Electric Co., Cleveland, O. Booth F-23.

Arc-welding machines equipped with "dual continuous control" will be in operation. A small-capacity welder will also be operated, demonstrating its capacity for sustained peak loads. Welding electrodes of various types will be demonstrated, and arc-welding accessories will be exhibited.

In attendance: A. F. Davis, vice-president; C. M. Taylor, vice-president; Art Madson, welding instruction; V. Peters, welding technician; E. W. P. Smith, consulting engineer, and the following Cleveland representatives: W. S. Stewart, district manager, F. W. Kessler, G. A. Sohl and R. E. Hass.

Magnaflux Corporation, Chicago, Ill. Booth N-15.

Display of magnetizing equipment and demonstration of inspection of specimens.

In attendance: A. V. DeForest, president; Chas. McCune, secretary; F. B. Doane, vice-president, and C. E. Betz, technical director.

P. R. Mallory & Co., Indianapolis, Ind. Booth H-26.

Photographic presentation of actual performances of various materials for resistance-welding dies and other special shapes. Also, electrical contact materials for a wide variety of applications in the automotive, electrical and industrial fields will be on display.

In attendance: J. A. Weiger, vice-president; J. D. Tebben, Detroit district sales manager; L. E. Arnold, Cleveland-Pittsburgh district sales manager, and P. N. Cook, advertising department.

Metal & Thermit Corp., New York, N. Y. Booth H-27.

Arc welding with heavy-mineral-coated electrodes will be demonstrated, and test specimens will be shown, also sample welds made by both the arc and thermit processes. Equipment for thermit welding will also be on display.

In attendance: J. H. Deppeler, chief engineer; H. T. Thompson, Pittsburgh manager; E. E. Radcliffe, Cleveland representative; J. Knapp, welding engineer, and J. Plaskon, welding engineer.

National Cylinder Gas Co., Chicago, Ill. Booth M-44.

A demonstration will be given of cutting simple and intricate shapes with an oxyacetylene cutting machine. Automatic cutting will be done with the use of a templet, and manual cutting by following the lines of a drawing.

In attendance: H. C. Dowson and H. E. Winkleman of Chicago, and the following Cleveland representatives: R. J. Hurt, district manager, A. C. Arnold, B. M. Kimball, J. L. Colopy and M. E. Fassnacht.

Page Steel & Wire Division, American Chain Co., Monessen, Pa. Booth C-23.

Exhibiting complete lines of welding wires, both arc and gas, with stainless-steel wire featured. Samples of stainless-steel fence and other stainless-steel products will be on display.

In attendance: J. J. Flaherty, manager wire department; F. H. Jones, district sales manager; W. H. Bleecker, sales manager.

Republic Steel Corp., Cleveland, O. Booth E-6.

Displaying applications of alloy steels, including stainless and heat-resisting steels, low-alloy high-strength steels, enameling stock, galvanized sheets, tin plate and other products.

John A. Roebling's Sons Co., Trenton, N. J. Booth O-12.

Demonstration, including special features, of wire rope and miscellaneous wires.

In attendance: R. R. Newell, branch manager, Cleveland; A. E. Gaynor, assistant manager, New York; R. S. Johnson, chief of research department, Trenton; F. J. Mapel, advertising manager, Trenton; Eugene King, salesman, Cleveland, and E. T. Weart, salesman, Chicago.

Joseph T. Ryerson & Son, Inc., Chicago, Ill. Booth I-22.

Displaying steels and allied products, including welding rods.

In attendance: A. Y. Sawyer, G. Van Dyke, F. S. Doran, W. O. Springer, William Braund, F. D. Roberts and G. V. Proctor.

Safety Gas Lighter Co., Lynn, Mass. Booth I-33.

Demonstrating use of round-file gas lighters for welders' use and household appliances, also other types of hand gas lighters, stationary ignition equipment, and exhibit showing origin and development of gas lighters from inception in 1901 to present day.

In attendance: K. P. Hill, vice-president, and W. T. McNally, field representative.

Stoody Company, Whittier, Calif. Booth N-8.

Display and demonstration of hard metals and their applications; also a motion picture, in colors, showing their use.

In attendance: J. R. Spence, metallurgist, and G. F. Staley, sales representative.

Una Welding, Inc., Cleveland, O. Booth H-23.

Demonstration of shielded-arc welding under full automatic control, also display of coated rods and demonstration of their use in building-up worn surfaces and welding low-alloy high-tensile steels. Samples of welds, test bars and test plates will be on display.

In attendance: N. T. Jones, vice-president and general manager; E. W. Kronbach, treasurer; E. D. Moore, chief engineer; W. G. Hall, development engineer; H. P. Blum, district sales representative; J. S. Vocler, sales engineer; C. M. Schaub, sales engineer, and J. E. Jones, sales representative.

Welding Engineer Publishing Co., Chicago, Ill. Booth M-49.

Display of literature on welding, cutting and allied processes.

In attendance: F. L. Spangler, editor; L. C. Monroe, advertising manager; T. E. Depew, eastern manager, and J. G. Holcombe.

Williams & Co., Inc., Cleveland, O. Booth O-39.

Displaying nickel, aluminum, brass and copper, welding electrodes, welding machines, boiler tubes, and head and eye protection. Arc welding with various types of electrodes will be demonstrated.

In attendance: J. H. Penske, Jr., district manager; N. J. Carbis; H. F. Roberts, nickel-iron specialist; J. E. Wolcott, welding specialist; A. M. Turner, D. J. Connelly, H. D. Lucas and D. A. Cameron.

Wilson Welder & Metals Co., Inc., New York, N. Y. Booth G-7.

Showing arc-welding machines in operation.

In attendance: T. B. Hasler, Ira B. Yates, W. L. Humphreys, E. Walters, G. H. Sandberg, P. Mattern and M. J. VanDreseer.

Program of 16th Fall Meeting, American Welding Society, at the Hotel Cleveland, Cleveland, O., Oct. 19-23

MONDAY, OCTOBER 19

9:45 a. m. Ball Room—Business Session. President J. J. Crowe, presiding.

Report on society activities by President Crowe.

Tellers' report on election of officers.

Award of Samuel Wylie Miller Memorial Medal.

Review of committee and section activities by chairmen.

Discussion.

2:00 a. m. Ball Room—Technical Session. Chairman, A. E. Gibson, The Wellman Engineering Co. Vice-chairman, E. Vom Steeg, General Electric Co.

Welcome address by local official.

"Fundamentals of Metallurgy of Welding," E. S. Davenport and R. H. Aborn, United States Steel Corp.

"Multi-Layer Oxyacetylene Pipe Welding," R. M. Rooke, F. C. Snacke and A. N. Kugler, Air Reduction Sales Co.

High-speed motion pictures of various welding processes, E. Vom Steeg, General Electric Co., and W. E. Crawford and Walter Richter, A. O. Smith Corp.

6:30 p.m. Parlor—Dinner and meeting, Board of Directors.

Review of society activities, appointment of committees and officers, new business.

TUESDAY, OCTOBER 20

9:45 a. m. Ball Room—Technical Session. "Fundamental Research in Welding." Chairman, H. M. Boylston, Case School of Applied Science. Vice-Chairman, E. R. Fish, Hartford Steam Boiler Inspection & Insurance Co.

"Heating by the Proximity Effect," Edward Bennett, University of Wisconsin.

"Impact Tests of Welds at Low Temperatures," Otto Henry, Brooklyn Polytechnic Institute.

"Characteristics of a Universal Welding Generator," N. F. Ward, University of California.

2:00 p.m. Ball Room—Technical Session. "Fundamental Research of Welding." Chairman, H. W. Gillett, Battelle Memorial Institute. Vice-Chairman, R. E. Kinkead, consulting engineer.

"Welded Beam-Column Connections," Inge Lyse and G. V. Gibson, Lehigh University.

"Circuit Characteristics and Arc Stability," S. C. Osborne, Wilson Welder & Metals Co., Inc.

"Welded Structural Brackets," C. D. Jensen, Lehigh University.

7:30 p. m. Conference and Meeting of Fundamental Research Committee, Bureau of Welding Research and Engineering Foundation. Chairman, H. M. Hobart, General Electric Co.

WEDNESDAY, OCTOBER 21

9:45 a. m. Ball Room—Technical Session. Chairman, A. F. Davis, The Lincoln Electric Co. Vice-Chairman, C. A. McCune, Magnaflux Corp.

"Brazing with Silver Solders," Robert H. Leach. Handy & Harman.

"Importance of Design Control for Welded Piping Systems," T. W. Greene, The Linde Air Products Co.

"Principles of Surfacing by Welding," E. W. P. Smith, The Lincoln Electric Co.

"Technique for Resistance Welding Ferrous and Non-Ferrous Sheet Metals," E. I. Larsen, P. R. Mallory & Co.

2:00 p. m. Ball Room—Technical Session. Chairman, Hugh H. Dyar, The Linde Air Products Co. Vice-Chairman, J. B. Tinnon, Metal & Thermit Corp.

"Procedures for Control of Welding Parts," G. H. Moore, Jr., Newport News Shipbuilding & Dry Dock Co.

"Welding Copper and Its Alloys—A Review of the Literature," Ira T. Hook, American Brass Co.

"Resistance Welding of Dissimilar Metals," R. T. Gillette, General Electric Co.

"Thermit Welding," J. H. Deppeler, Metal & Thermit Corp.

"An Exploration of the Modern Metallic Arc," L. J. Larson, A. O. Smith Corp.

10:00 p. m. Stag and Entertainment. Alpine Village, Exposition grounds.

THURSDAY, OCTOBER 22

9:45 a. m. Joint Session with American Society of Mechanical Engineers. Chairman, C. W. Obert, Union Carbide & Carbon Research Laboratories. Vice-Chairman, Milton Male, United States Steel Corp.

"Welding Design," C. H. Jennings, Westinghouse Electric & Manufacturing Co.

"Alloy Steels and Their Weldability," A. B. Kinzel. Union Carbide & Carbon Research Laboratories.

"Welding of Alloy Steels," W. L. Warner, Watertown Arsenal.

2:00 p. m. Joint Session with American Society of Mechanical Engineers. Chairman, H. F. Henriques, Air Reduction Sales Co. Vice-Chairman, S. M. Weckstein, Timken Roller Bearing Co.

"Rolled Steel in Machine Construction," H. G. Marsh, Carnegie-Illinois Steel Corp.

"Welding Heavy Machinery and Equipment," C. A. Wills and F. L. Lindemuth, The Wm. B. Pollock Co.

Discussions by E. E. Tross, United Engineering & Foundry Co., and F. O. Leitzell, Lewis Foundry & Machinery Co.

"Modern Resistance-Welding Developments," A. E. Hackett, Thomson-Gibb Electric Welding Co.

7:00 p. m. Dinner dance with entertainment.

FRIDAY, OCTOBER 23

Meeting of the American Society of Mechanical Engineers. (The American Welding Society has not arranged any technical sessions for Friday, but members are invited to attend the sessions of the A. S. M. E.)

9:30 a. m. Technical Session. Chairman, A. E. Gibson, The Wellman Engineering Co. Vice-Chairman, Guy Hubbard, Penton Publishing Co.

"Application of Copper-Alloy Welding," I. T. Hook, American Brass Co.

"Welding of Monel Metal and Pure Nickel," F. G. Flocke and G. F. Schoener, The International Nickel Co.

"Welding the Aluminum Alloys," by G. O. Hoglund, Aluminum Co. of America.

2:00 p. m.—Technical Session. Chairman, R. E. W. Harrison, Machine Shop Practice Division, A. S. M. E. Vice-Chairman, D. M. Gurney, The Warner & Swasey Co.

"Magnaflux Inspection of Large Welded Vessels."

"Radiographic Inspection of Welded Refinery Equipment and Steel-Plate Construction," H. R. Isenburger, St. John X-Ray Service.

"Principles Involved in Selecting Casting vs. Welding," J. L. Brown, Westinghouse Electric & Manufacturing Co.

Discussions on Physical Tests

The Institute of Metals and Iron and Steel Divisions of the A. S. M. E. will hold a joint session at 2 p. m., Thursday, Oct. 22, with a round-table discussion of physical tests and their significance. Under the subject of impact testing, S. L. Hoyt will lead a discussion on the transverse notched bar test, while H. C. Mann will lead a discussion on the tension impact test. Under the subject of bend testing, J. R. Townsend will lead a general discussion of bend tests, while Wilber B. Miller will lead a discussion on bend testing as applied to welds.

WOMEN'S PROGRAM

MONDAY, OCTOBER 19

10:00 a. m. Hotel Cleveland—Registration opens.

3:30 p. m. Hotel Cleveland.—Tea and reception. Mrs. Alfred E. Gibson, hostess, presiding.

TUESDAY, OCTOBER 20

1:00 p.m. Higbee Silver Grill Tea Room—Luncheon and style show.

2:30 p. m.—Bus sight-seeing tour of city and suburbs.

WEDNESDAY, OCTOBER 21

1:30 p. m. Terminal Tower—Observation trip.

8:00 p. m. Radio Station WHK—Attend broadcast.

10:00 p. m. Hotel Cleveland—Light supper.

THURSDAY, OCTOBER 22

7:00 p. m. Hotel Cleveland—A. W. S. annual dinner dance.

Abstracts of Papers

The American Welding Society has made available the following abstracts of certain papers to be presented at the Fall Meeting

MULTI-LAYER OXYACETYLENE PIPE WELDING—By Rooke, Saacke and Kugler

Scheduled for Monday Afternoon.

In the multi-layer method of pipe welding, first a thin layer of weld metal, from 2 to 6 in. long, is deposited in the bottom of the groove between the two pipes to be joined. After this layer has cooled below a red heat another layer is deposited. And so on, until the entire groove between the plates is filled and the weld is completed. For a pipe 1 in. thick, four layers are usually sufficient, the last layer deposited being as thin as possible.

Although the multi-layer method may seem at first more complicated than the single-layer method, tests have shown that the reverse is the case in practice.

The multi-layer welding method simplifies much of the welder's difficulties in manipulating a large pool of molten steel, especially in welding heavy-wall pipe. Incidentally, the simplification involves a speeding up of the welding so that multi-layer welds are quicker to make than single-layer welds. Besides simplifying the welder's job, the multi-layer method consumes less welding rod and gases. From the cost standpoint, the new multi-layer method is therefore superior for thick pipes, compared to the old single-layer method.

It is also found that welds made by the multi-layer method are practically as strong as, and considerably more ductile and shock resistant than, single-layer welds. The improvement in toughness of the multi-layer welds is due to the small size of the individual layers. A small layer of molten steel is deposited more rapidly and freezes more quickly than a large layer. The layers of a multi-layer weld are therefore exposed to the contaminating influences of the atmosphere for a shorter time than single-layer welds.

A further increase in ductility with very little sacrifice in strength is provided by the beneficial heat effect of succeeding layers of weld metal on cool welded steel. The heat effect refines the grain of the first layers of welded steel. In other words, the large crystals of steel of which a single layer of weld metal consists are broken up into much smaller crystals. For example, the length of an individual crystal of steel in a single layer weld may be as much as 1/10 in. The heat effect of another layer of weld metal deposited on the original layer reduces the size of the individual crystals to approximately 1/10000 in. In this way a few large crystals are replaced by myriads of small crystals with a resulting improvement of up to 5000% in toughness and ductility.

Applications of the multi-layer method of oxyacetylene welding to the installation of high-pressure steam piping in two modern power plants, are described. In one of these plants, the welded pipe carries steam at 750°F. and 625 lb. per sq. in. pressure.

On these two installations, on leaks, sweats, or other evidences of failure were developed under the usual preliminary test under water pressure at 1½ times operating pressure. The pressure piping in both plants has been in service for over a year and is giving thoroughly satisfactory service.

Competent welders report that the multi-layer method permits them to overcome some of the difficulties of fusion inherent in the single-layer method. That the welds made by the new method are superior to single-layer welds was indicated by tests on a large number of specimens cut from pipes of several sizes welded by both methods.

METALLURGICAL ASPECTS OF THE WELDING OF STEEL—By Davenport and Aborn

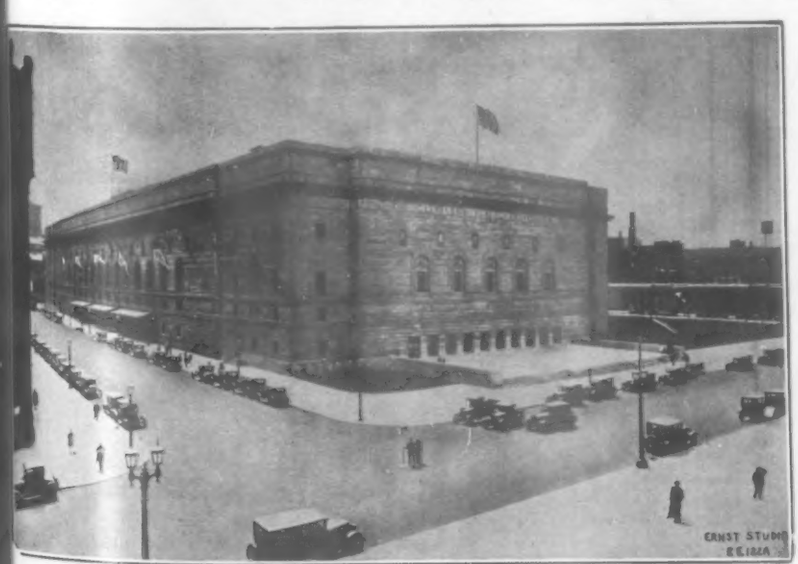
Scheduled for Monday Afternoon.

Although the fireworks of welding are spectacular to watch, it is during the quiet cooling of a weld that its strength and toughness are developed. For white-hot steel has, of course, practically no strength at all. The valuable combination of strength and toughness that is characteristic of steel and of welds in steel is largely a product of the changes that take place in the internal structure of steel at temperatures between normal room temperature and a dull-red heat.

At ordinary temperatures, steel, which is iron containing up to 1½% carbon, is normally a mixture of a soft material called ferrite (nearly pure iron) and an extremely hard material called cementite (a chemical compound of iron and carbon). Steels normally tend to be composed of ferrite and cementite mixed together as minute plates which are seldom more than 1/25000 inch in thickness. If, however, the steel is cooled very rapidly from a dull-red heat—by dipping in water, for instance—the mixture of hard and soft materials may be replaced by a single material known as martensite, which is hard and brittle. Had the steel been heated just below a dull-red heat, known as the critical temperature, before being dipped in water, the steel would actually have been slightly softened instead of hardened.

The conditions of welding are such that the steel in and adjacent to the weld is heated to all temperatures up to the melting point, and cooled rapidly. Some zones of the steel near the weld are heated just high enough so that, upon cooling, they are a little softer than the original steel. Other zones have been heated above a dull-red heat, and upon cooling become somewhat harder than the original steel. In the first case, the cementite plates have become rounded into globules by being heated just below the critical temperature. In the second case, some of the steel tends to assume the hard, brittle form.

The multiplicity of changes occurring in steel during welding, giving rise to



Cleveland Public Auditorium, where the Metal Exposition will be held.

five distinct zones, is illustrated by means of photographs of the internal structure or architecture of steel. The photographs were prepared by means of a microscope capable of enlarging the structure up to 1,500 times.

Besides shedding much light on the scientific aspects of welding, the observations show that welds in steel are surrounded by two zones: one softer than the original steel, the other harder and more brittle. Just how soft or hard the zones may be, depends on the precise conditions of the welding operation and also upon the composition of the steel.

In ordinary steels, the hard and soft zones are very little, if at all, different from the original steel. In some alloy steels containing copper, nickel, chromium, or other alloying elements, the hard zone may be hard or the soft zone excessively soft. A carefully reasoned outline of the metallurgical principles of welding provides the basis for overcoming the difficulties experienced with troublesome steels.

HIGH SPEED MOTION PICTURES OF FLASH WELDING—By Crawford and Richter

Scheduled for Monday Afternoon.

Flash welding is a form of electric-resistance welding in which the surfaces of two parts to be joined are brought to incandescence by means of powerful electric flashes. When the surfaces are at the melting point, usually a matter of two or three seconds, the weld is made by pressing the parts together.

In an attempt to answer the question, what happens during flash welding?, edge-on motion-picture frames of flash welding mild steel were made at speeds up to 1,200 frames per second. A careful study of these motion pictures showed that the flashing operation employed in flash welding is not characterized by a condition of uniform arcing. That is to say, at the point of contact of the surfaces to be welded together an arc forms momentarily, and is extinguished in a small fraction of a second and replaced by another arc at some other point of contact of the two surfaces. During the period of a single flash or arc there occur at irregular intervals violent expulsions of incandescent particles of steel.

The important discovery is that each expulsion or shower of incandescent material occupies only a very limited duration of time—about 1/500 second. The expulsion may occur from both sides of the contacting surfaces simultaneously or may be confined, in unusual cases, to one side.

Motion pictures of the flash in flash welding are being studied with oscillographic records of the electric current consumed by the flash. When the results of the experiments made by the formidable combination of high-speed motion-picture camera and oscillograph have been completely analyzed, scientific information of the highest importance to the development of flash welding may be expected.

WELDED STRUCTURAL BRACKETS—By Jensen.

Scheduled for Tuesday Afternoon.

Small transparent celluloid models of eight types of welded brackets, subjected to loads similar to those expected in service, were examined in polarized light by the photoelastic method.

Portions of the bracket carrying little load as revealed by the photoelastic pattern were cut away from the bracket with little loss of strength. The process of cutting away useless portions of the model bracket was continued until all parts of the bracket supported the load to an equal stress. The flow of load from beam to column was then uniform, and the most economical design had been evolved.

The best types of welded brackets having been suggested by these experiments, actual welded steel brackets, consisting of two plates at right angles and a stiffening web, were next fabricated for test. Altogether, 24 full-size welded brackets, coated with whitewash, were subjected to increasing load until fracture occurred. During the tests, the changes in shape of important parts of each bracket were measured by means of extensometers, and indications of failure of the bracket were given by cracking of the whitewash coat.

With the information available from both the celluloid models and the full-size welded specimens, the final step in the design of welded brackets was to discover a design formula. With this formula brackets for each of the many conditions of load likely to be encountered in service may be computed with simplicity and accuracy. It is interesting that the proposed formula is in excellent agreement with the theoretical calculations regarding the bracket as a unit of homogeneous material. The tests therefore showed that welded brackets may be considered, for the purposes of structural design, as continuous members integral with column and beam.

WELDED BEAM-COLUMN CONNECTIONS—By Lyse and Gibson

Scheduled for Tuesday Afternoon.

An exhaustive investigation into welded building construction, conducted by the Fritz Engineering Laboratory at Lehigh University, has provided those who design welded buildings with the solution of one of their most pressing problems—namely, in what way should the floor beams of a building be joined to the upright columns? There are, of course, many possible ways of joining, but which method is most economical, consistent with accepted notions of safety? The method of design developed at Lehigh is applicable to a wide range of light-weight beams of moderate length.

The function of the floor beams of a steel building is to carry the weight of the floor resting upon it and to transmit the floor load to the upright columns, which in turn transmit the load to the foundations. Of the many possible methods of attaching a floor beam to a column, the best appears to involve the use of steel angles. A steel projection or angle is welded to each of two columns. The ends of the beam are then supported on the angles and additional angles welded to the top of the beam and to the column.

The Lehigh tests showed the best arrangement of angle seats so that failure of the welded beam-column assembly under excessive load will not occur at the angle connections but at the center of the beam. Such an arrangement is at once most economical and strongest because the full stength of the floor beam is utilized.

The tests upon which the method of design is based, were made on full-size floor beams welded to heavy structural-steel columns. The welding was performed by means of covered electrodes.

In one test the small steel projections or angles, which were only 3 in. long, deformed to the extent of ½ in. before the welds failed. In another test of a floor beam, 18 ft. long and 1 ft. high, it was impossible to cause the welds to fail before the beam itself buckled.

An important advantage of welding over other types of joining was clearly shown in the course of the tests. It was found that the strength and rigidity of the welded connection could be changed simply by distributing the welding over different areas of the angle seats. In this way, savings up to one-third in the size of the floor beam were made possible by altering the rigidity of the connection. Using other methods of joining, changes of rigidity can be made only by elaborate alterations in the type of connections.

The so-called top-angle connection, shown by the Lehigh tests to be the most suitable type of connection for light-weight floor beams, was found to have considerable reserve strength when compared with the methods of design that have been worked out.

WHEN AND HOW SILVER SOLDERS ARE USED—By Leach

Scheduled for Wednesday Morning

Soldering differs from welding in that the metal parts are never melted. The soldered joint depends for its strength on other factors than fusion such as absorption and adhesion.

Silver soldering is no different in prin-

ciple from soldering with plumber's or tinsmith's solder, which is familiar to everyone. But whereas ordinary solder is made of tin and lead, and melts at about 300°F., silver solder is made of silver and copper, with usually some zinc, and melts at higher temperatures: 1,200° to 1,600° F.

The advantages of silver solder over other types of solder are: (1) strength; (2) resistance to vibration and shock; (3) resistance to corrosion; and (4) ease of fabrication. Practically all metals that can be heated without danger to 1,200°F. can be silver soldered.

The strongest silver-soldered joints are made with the remarkably small gap of 1½ thousandths of an inch between the parts to be joined. Being so thin, the joint has a neat appearance. In many cases the silver-soldered joint is invisible to the naked eye.

A silver-soldered assemblage of 1-in. brass pipe, is mentioned, which withstood a water pressure of 4,300 lb. per sq. in. without failure. Under direct loading one of the brass fittings fractured but the silver-soldered joints remained sound.

In addition to its high strength, which makes silver soldering suitable for joining electrical parts or piping that must withstand temperatures up to 850° F., the silver-soldered joint has good corrosion resistance. Silver soldering is used especially in chemical equipment in which joints are exposed to severe corrosion by acids or other reagents.

Recent developments in silver soldering have made it extremely easy to produce excellent joints. A method that is often used for pipes requires simply a torch and a ring of silver solder of the same diameter as the pipe. The torch is fed with illuminating gas and air or oxygen. The ring of silver solder is slipped over the pipe to be soldered. The fitting is then slipped over the pipe and the ring. The joint is heated uniformly with the torch until silver solder is seen oozing out at the edge of the joint. Nothing more need be done.

Other developments include dip brazing (in which the joint to be made is dipped into a bath of molten silver solder) and resistance brazing. In the latter method inserts are used as described above, but the heat is supplied electrically rather than by a torch.

PRINCIPLES OF SURFACING BY WELDING—By Smith

Scheduled for Wednesday Morning.

The problem is outlined of using materials, especially expensive materials, only where the service demands. For example, in aircraft the general principle adopted is to reduce the weight to the minimum by using light-weight materials, such as aluminum, and light methods of construction wherever possible. Nevertheless, several heavy metals are used in airplanes. Copper, almost 3½ times heavier than aluminum, is used for electrical conductors. Lead, about 4½ times heavier than copper, is used for engine bearings, although aluminum bearings are now being developed. Likewise, steel, though it is 3 times heavier than aluminum, is essential for magnets in the electrical generating system.

The general principle of adapting the material to the service has only recently been satisfactorily applied by the railroads to the repair of worn rail joints. One of the minor sources of annoyance in a railway journey is the clatter and vibration produced by the wheels passing over the gap between rails every 30 ft. or so. The pounding of the wheels on the rails at the joints causes rapid wear, which, in turn, increases the pounding or batter at the joints.

While rails made of an exceedingly hard metal would largely eliminate wear at the joints, they would be prohibitively expensive. Therefore the problem of wear at the joints remained unsolved until the adoption of surfacing, by which a small amount of hard but expensive steel is fused onto the worn ends of a rail just where hardness is needed to prevent wear.

Primarily, the adoption of surfacing for a particular application is governed by a delicate balance between properties and price. The question is: Is it cheaper to fuse a thin layer of expensive material onto inexpensive mild steel, or to make the entire part from the expensive material? In the majority of cases, surfacing by welding is not only demanded by the nature of the service, but is less expensive.

Also, surfacing electrodes are on the market today that meet specific requirements other than hardness. There are electrodes which produce a surface that will not chip or crack under shocks, such as hammer blows. Others are resistant to the grinding action or abrasion due to the contact of metal with rock, sand, or other metals. Abrasion-resistant electrodes are used for surfacing the jaws of rock crushers and the teeth of steam shovels. But the composition of the electrode for the rock crusher, for example, would be entirely different from the electrode for steam-shovel teeth to operate in sandy ground.

Electrodes have also been invented for producing surfaces resistant to corrosive chemicals, such as acids, and to the action of corrosive gases at high temperatures. Even ordinary air corrodes steel at a red heat. By applying a thin layer of an electrode of appropriate composition, a large mass of inexpensive mild steel may be rendered immune to corrosive conditions of any degree of severity.

The different types of electrodes may be used singly or in combination for a given application. An example is cited of a cutter used for cutting fibrous material in the presence of vegetable acids. The tip of the cutter was required to cut, the sides to resist abrasion, and the entire cutter to resist corrosion. To have used a single metal for the entire cutter would have resulted in a compromise. Instead, the body of the cutter was made of an inexpensive steel resistant to the particular vegetable acid involved. The tip was then surfaced with a hard tool steel which takes an excellent cutting edge. The sides were surfaced with an abrasion-resisting electrode.

Surfacing by arc welding is also used for metal-cutting tools. Such tools must retain their hardness at the high temperatures (up to 1300°F.) developed in modern high-speed lathes and other metal-cutting machinery. An electrode suitable for surfacing such tools may contain cobalt, chromium, and tungsten. These three metals are quite expensive. The proportion of the expensive electrode that need be used to surface the tip of a tool is so small that the overall cost of the tool is surprisingly low.

If the conditions of service are known, a suitable electrode is readily selected. Once the selection of the electrode is made, the decision whether surfacing is economical can be made on the basis of a simple calculation.

AN EXPLORATION OF THE MODERN WELDING ARC—By Larson

Scheduled for Wednesday Afternoon.

Although investigators know fairly well what happens in the metallic arc, they still do not know why it happens. The experiments described showed first of all that more heat is available in the arc of a covered electrode than in the arc of a bare electrode. Consequently, the covered electrode is melted faster and welding is more rapid than with the bare electrode. The extra heat in the covered electrode also provides better fusion with the plate metal than is possible with the bare electrode.

The heat of the covered-electrode arc melts the steel core; but for some reason, to be elucidated perhaps by further experiments, the molten metal passes from electrode to plate through the arc space in the form of minute liquid globules. Occasionally globules over 1/100 in. in size pass across the arc space. But for every globule of such comparatively large size there are over one hundred droplets 1/1000 in. in size.

Furthermore, at any given instant the amount of metal in the act of passing from the electrode to the part to be welded occupies not so much as 1/10 of 1% of the arc space between electrode and plate. Measurements showed that the time of passage was about 2/1000 of a second for a large globule and

1/10000 of a second for a small globule. The globules travel at speeds up to 120 miles per hour. According to our modern ideas of transportation, the speed is moderate. Perhaps something can be done to speed up the globules and so speed up welding.

In bare-electrode welding the globules are many times larger than in covered-electrode welding. Therefore, the functions of the covering on an electrode was investigated. The covering used consisted of water glass and paper (cellulose). When the arc was struck the steel core of the electrode melted up beyond the end of the covering, thus forming a short tube around the arc. The covering then disintegrated at the same rate as the steel melted. The covering, upon distintegration, produced a slag, which acted as a blanket on the pool of molten steel and served to purify the steel. In addition, the covering evolved a gas, which consisted principally of hydrogen and carbon monoxide, also a little steam and carbon dioxide, as well as an unknown amount of vaporized iron. The temperature in the arc was about 11,000°F., whereas the temperature at which iron boils is only 8,000°F. These gases are entirely different from the gases present in the arc space of a bare electrode. The difference in composition of the gas explains to some extent the superlative character of covered-electrode arc welding.

As the gases were evolved from the coating, they rushed outward from the arc space at a speed of over 70 miles per hour. The outward rushing stream of hydrogen and carbon monoxide—gases which do not have a damaging effect on molten steel—prevented the infiltration of air into the arc space. As is well known, air should always be excluded, if possible, in the manufacture of high-quality steel.

These experiments provide the materials for a mental picture of the modern welding arc: Within the blinding glare of the arc space tiny globules of molten steel are speeding from the covered electrode to the parts to be welded. At the same time a blast of harmless gases evolved from the coating is rushing outwards from the arc space, preventing access of air to the pool of weld metal. The weld metal deposited in this way by the covered electrode is equivalent to high-grade steel and has the same strength and ductility as steel produced by the steel mill.

ARC WELDING OF STRUCTURAL ALLOY STEELS—By Warner

Scheduled for Thursday Morning.

The low-alloy structural steels, of which at least twelve varieties are manufactured, have about 50% greater strength than mild steel, with almost equal ductility. The increased strength of the low-alloy steel is obtained through suitable combinations of the alloying metals: silicon, manganese, copper, chromuim, nickel, and molybdenum.

The transition from mild steel to low-alloy structural steel has been closely followed by developments in the welding industry. Unfortunately, each of the varieties of low-alloy steel that have been produced has presented a new problem to welding engineers, to whom a multiplicity of welding rods have been offered for use with each variety of steel.

The difficulties encountered in welding low-alloy structural steels are connected with the brittleness of the welds. During welding, the steel in a thin zone on each side of the molten weld metal is heated to temperatures up to the melting point. The subsequent cooling in air after welding is sufficiently rapid in many steels to set up a brittle condition. In its brittle condition the steel is subject to cracking under very small loads or shocks. To be successful, a weld in low-alloy steel must not be accompanied by a brittle zone, which may cause cracking during cooling after welding is finished.

A large number of tests designed to exaggerate the brittle condition indicated that the greatest hardness found anywhere in the weld and its vicinity is a good indication of the brittleness of the weld.

With this fact established, the definition of weldability can be stated as follows: A steel is weldable if it can be welded by welders of ordinary competency without undue precautions, so that the resulting weld is free from cracks and the brittle zone. With this reasonable definition, the weldability of a steel can be determined by measuring the greatest hardness in the weld and its vicinity—a relatively simple operation using the Vickers or any similar hardness-testing machine.

On the basis of a large number of hardness or weldability tests on a wide range of steels with and without the alloying elements characteristic of low-alloy steels, it was found that the welding difficulties associated with low-alloy steels are not brought about by the alloying metals but by a hitherto unsuspected factor—namely, the carbon content of the steel. So long as the carbon content of the steel was below ¼ of 1%, it made little difference to the weldability what alloying elements were present up to the limits usually found in low-alloy structural steels.

In particular, it was found that nickel, hitherto regarded as exerting a damaging effect on the weldability of steels, had actually no serious effect whatever. Copper and molydenum were also declared innocent of the charge of causing poor weldability which had frequently been brought against them.

The deductions made on the basis of these weldability tests were verified by a series of tests of the strength and toughness of welds under static and shock loads. The shock or tensile impact tests were performed both at room temperature and at temperatures as low as —100° F. Besides confirming the weldability tests, the impact tests showed that welded joints in low-alloy steels of suitable alloy content and low carbon content have excellent strength and toughness at low temperatures.

MEETINGS

Philadelphia

At the meeting of the Philadelphia Section, American Welding Society, on Sept. 21, Jos. W. Meadowcroft, assistant works manager of the Edward G. Budd Manufacturing Co., gave a talk on "Modern Day Welding in the Automotive and Railway Fields." The next meeting of the Section will be held on Monday evening, Oct. 26.

Chicago

"Welded Piping Systems" is the topic of the meeting of the Chicago Section, American Welding Society, to be held on Friday, Oct. 16, at 7:30 p.m. in Mission Hall, Armour Institute, 47 West 33rd St. The speakers will be F. C. Fantz, vice-president, Midwest Piping and Supply Co., of St. Louis, and Mr. Garrison, of the Carbide & Carbon Chemicals Corp., Chicago.

The Chicago A.S.M.E. group will hold a meeting on Wednesday evening, Oct. 7, in the Hotel Sherman, on the subject "Solving Manufacturing Problems by the Use of Welding," at which round-table discussions will be held. The members of the Chicago Section, American Welding Society, have been invited.

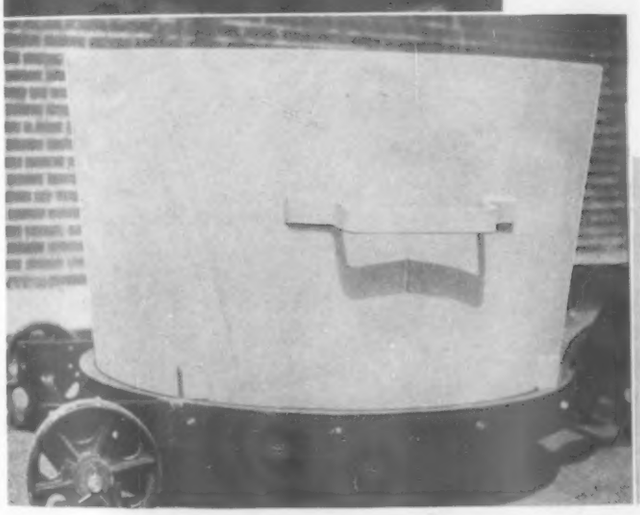
At the Welders' Information Center, 741 West 70th St., the meeting on Tuesday evening, Oct. 6, will be devoted to gas welding and cutting. Demonstrations will be in charge of Earl Evleth, H. A. Goodwin, Hugh Comiskey, and J. C. Owen, all of The Bastian-Blessing Co., and a demonstration of welding white metal with Aladdin rod will be given by J. C. Menzies, of C. E. Phillips & Co.

About 100 sat down to dinner in the Dental and Medical Arts Building, on Sept. 18, which was the first meeting of the Chicago Section, American Welding Society, to be held this season. This was in the nature of an "open house." J. C. Lincoln, of The Lincoln Electric Co., gave his impressions of welding in Europe, with particular reference to costs of welding equipment and electrodes compared to costs in the United States. J. F. Reid, of the Associated Factory Mutual Fire Insurance Cos., spoke regarding fire hazards in welding. A. M. Unger, of the Pullman-Standard Car Manufacturing Co., outlined his ideas on how the Society can best serve industry, and offered constructive suggestions.

Welding News in Pictures

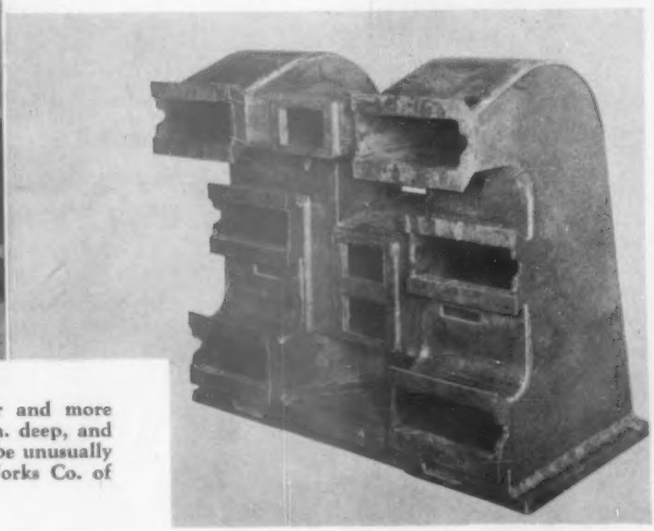
• (Left) Specially qualified electric arc welders at work on the $5,000,000 high-temperature steam installation at the Ford River Rouge power house—largest in the world. The 1,600 welded joints have to carry a pressure of 1,200 lb. per sq. in., the steam being heated to 900° F.

• Stream-lined oil truck-tanks present no difficulties to the Brown Steel Tank Co. of Minneapolis, which concern recently completed the attractive all-welded job shown above. The tank proper is of 10-gauge steel, the rear bucket being of 16-gauge material.

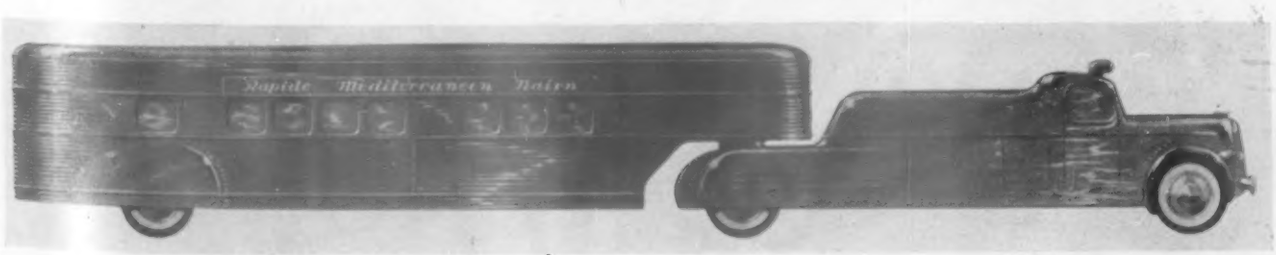


• This large welded stainless-steel varnish kettle is much lighter and more durable than if it had been riveted. It is 53 in. in diameter, 36 in. deep, and is made of 3/16-in. plate. A cast kettle of these dimensions would be unusually bulky and clumsy. This was made by the John Nooter Boiler Works Co. of St. Louis.

• (Below) An exceedingly expensive pattern was eliminated when this special grinding-machine base was welded together out of ¾-in. plate. Weighing 3,500 lb., this was built by the Lakeside Bridge & Steel Co. of Milwaukee.



• Wild tribesmen of the Syrian desert will have something to stare at when this light welded stainless-steel bus goes into operation between Baghdad and Damascus. The entire unit is 57½ ft. long, is air conditioned and is drawn by a 150-hp. diesel tractor. One bus similar to that shown will be a day coach carrying 19 passengers. Another will be a sleeper with upper and lower berths for 14 passengers. These buses will cover in 15 hours a distance that heavier buses now take 35 hours to travel.



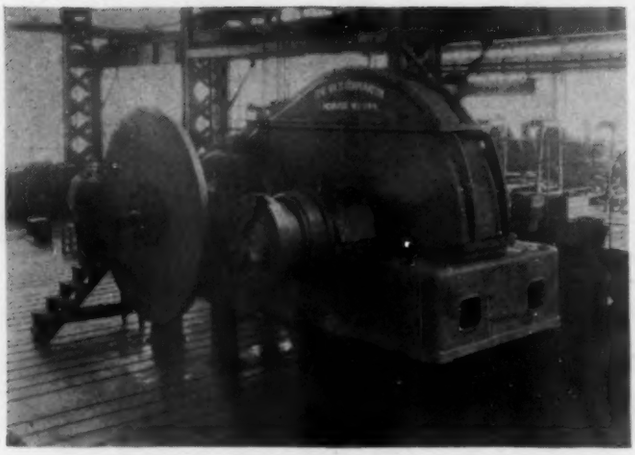


Fig. 1. Old Type of Steel-Mill Gear-Reduction Unit.

(The cover is a casting with two sections to be planed, drilled, and fitted together; this is an expensive construction and cannot easily be made in very large sections due to foundry limitations.)

Fig. 2. New Type of Steel-Mill Gear-Reduction Unit.

(The welded unit embodies smooth, even lines with no unnecessary projections, resulting in a design of much improved appearance over that shown in Fig. 1. The gears, bearings and lubrication system are entirely enclosed. The oil pan, which is not visible in the photograph, is welded onto the base, making a permanent oil-tight joint at less than half the cost of the former method in which the tank was planed off, the base was planed and drilled and tapped and the tank bolted to it.)

Combining STEEL CASTINGS AND PLATE *Economically* . . .

By HAROLD F. FALK
Supt. of Welding, The Falk Corp.

EVERY reputable manufacturer wishes to produce a product which will be satisfactory to his customer. At the same time, competition limits the amount which he can spend to make this product. Thus, he must hold to a high standard of quality while cutting manufacturing costs to the minimum.

If he is a manufacturer of heavy machinery, he has undoubtedly used iron or steel castings to a large extent and is now becoming interested in the use of rolled steel plate to supplement or replace these other materials, hoping thus to achieve as good a result at a lower cost.

Suppose he decides to go into welding. The first question is, what parts shall be made welded and what parts, if any, shall remain castings? Let us briefly consider two examples — the first of which lends itself best to welding, the second to casting.

Many Castings Are Profitably Replaced by Welding

The first example is illustrated by Figs. 1 and 2, showing respectively an old-style gear case made of cast steel and a modern case made of rolled steel with cast-steel bearing blocks welded in. Each complete case consists of three parts—a cover, a base and an oil pan. The cover, in both cases, is bolted onto the base. The cast-steel oil pan is bolted onto the base in the old unit and welded to the base in the new one.

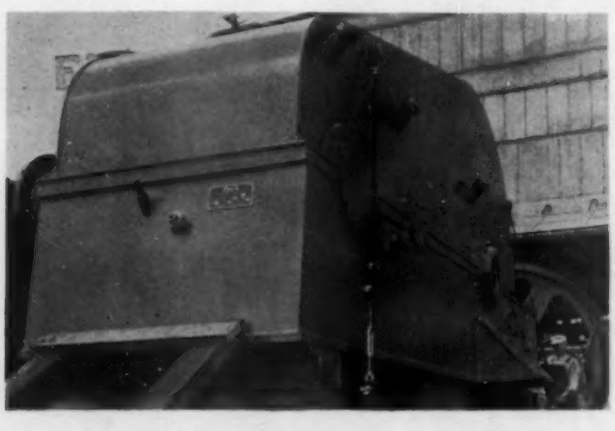


Fig. 3. Single-Reduction Steel-Mill Drive.

(This unit has two gears and an idler pinion in the center. The case without the gears weighs 53,000 lb. The base of this unit in process of assembly is shown in Fig. 4.)

Anyone trying to modernize the old cast gear case would probably be willing to admit without much argument that the cover should be changed over to welded steel plate. In the first place, the cast-steel cover must be of fairly thick section (about ¾ in.), not so much for strength as to make an easier job for the foundry. The welded cover, however, can be made of ⅜-in. or ½-in. plate, and will serve the purpose just as well.

The cast cover is again at a disadvantage when it comes to machining. Since it cannot be made as accurately, much more machining is required. The welded cover can be made to fit the base without having to be machined. This is equally true of both large and small units.

In addition, bosses and flanges for oil pipes and inspection holes must be cast on the old-style cover and machined with the cover. This requires the use of large and expensive radial and horizontal drill presses, planers and milling machines upon which the whole cover can be placed. But with the welded units, most of this work can be done before these parts are welded on, and only a small lathe and drill press are required.

On the two cases in questions, the machine-shop cost was actually three

times as much for the cast cover as for the welded one.

Having chosen to convert the cover to a welded job, we naturally look for the next piece which might be better welded than cast. Attention is brought to the oil pan. Just like the cover, it can be made stronger, lighter and with less cleaning and machining, if welding is the means of fabrication.

Now, with the cover and oil pan welded, the only part left for consideration is the main frame or base. This is essentially a beam which carries the bearings and holds them rigid enough to maintain perfect tooth contact and consequent well-distributed load upon each gear tooth. The base is the most important part of the unit. Since it offers no particular difficulties to either the foundry or the welder, it is not easy to decide how it shall be made. This question will be discussed in subsequent paragraphs.

Castings Are Still Economical Under Certain Conditions

In some places castings cannot be replaced by welding, with any advantage in cost. Take for example the gear case shown in Fig. 3. This unit weighs 53,000 lb., is about 6 ft. wide, 10 ft. high and 22 ft. long. It has two sets of cast-steel bearing blocks, of rectangular shape, between 3 and 4 ft. long, about 18 in. thick and 2 ft. deep. These are not solid blocks as they appear on the surface, but are cored out to get the proper distribution of metal for necessary strength without excessive bulk.

Let us look at the cost of this base, as given in the table on this page, noticing how the price per pound decreases when bases are made in quantities, which is due to the spreading of pattern costs over more than one unit.

In examining these cost figures, it is important to bear in mind the type and quality of the welds involved, as these factors alone can affect the total cost considerably. Remember that all welds are required to be as perfect as possible in quality; that they are all continuous, and all the important welds are scarfed completely through on plates of 1 to 1½ in. thick.

As often happens with steel-mill drives of this kind, there may be five or six units of similar construction on an order. Frequently the same bearing blocks may be used on all these units and the center distances changed for different gear ratios. It is in quantities like this that cast bearing blocks begin to come down into the price class of welded ones.

Gear cases of the type shown in Fig. 3 might be constructed with the side walls of the base made of cast bearing blocks, as shown in Fig. 4, with an all welded bearing block, as in Fig. 5. It will be shown that when quantities reach as many as six units the cost of casting the bearing block is about equal to that of welding.

Fig. 4. Main Frame of Unit Shown in Fig. 3.

(The frame is being tacked preparatory to welding. Note how the castings are set into the welded frame. Wherever the castings joined the plate, a ledge or shelf was cast integral with the casting to act as a backing-up strip for welding. One of these ledges is visible in the upper right-hand corner of the smaller casting. The cut-out in the plate is about ⅝ in. wider on each side than the outline of the casting. The plate is flame-scarfed at a steep angle (about 30°); this forms a groove with fairly steep sides, a ⅜-in. opening at the bottom to insure a good start for welding and a cleanly machined backing-up strip which is part of the casting.)

"Total Cost" indicated in the table below includes the cost of patterns and all other materials, labor and burden charges in the fabrication of a complete base.

Note that comparison is made on price per pound. Claims that welding saves weight are often true but do not hold good in the case of heavy blocks like these. Thus "price per pound" is a fair basis for comparison.

The reason for lower costs when units with cast bearings are made in lots of six is that a pattern cost of about $900 is spread over six units instead of one.

As this article is being written from the point of view of the steel foundry going into welding, the casting cost of 5.6c per lb. is used. The average foundry is able to make castings of this size at this cost. (This is not the selling price, however.)

Welders may claim that they can make the welded blocks cheaper in large quantities; as the foundryman can do the same with castings, this fact has been omitted from the figures and spreading of pattern costs was the only consideration.

Choosing the Best Combination of Casting and Welding

The foregoing material seems to point to the fact that for certain types of work it is advantageous for the designer to consider both casting and welding. Each method of construction has its place. Each has its limitations. These facts lead naturally to the combination of casting and welding in a single unit.

Having discussed an application such as a cover where welding is undoubtedly the best means of construction and, on the other hand, having considered a bearing block where in certain quantities casting is the more economical, let us go to a more complex problem—that of choosing suitable materials for a base having sides like the one shown in Fig. 5. Let us assume that six of these bases are to be made. The foregoing table

Cost Comparisons Between Two Types of Bases.

	Weight of Plate	Weight of Castings	Total Weight	Total Shop Cost per Unit*	Cost of Base per Pound
BASE WITH CAST-STEEL BEARING BLOCKS					
Illustrated in Figs. 3 and 4	23,942 lb.	13,757 lb.	37,699 lb.	$3,665	9.7c in lots of 1
	23,942 lb.	13,757 lb.	37,699 lb.	2,847	7.3c in lots of 6
Similar to Figs. 3 and 4	13,960 lb.	10,430 lb.	24,390 lb.	2,336	9.6c in lots of 1
	13,960 lb.	10,430 lb.	24,390 lb.	1,558	6.4c in lots of 6
BASE WITH ALL-WELDED BEARING BLOCKS					
Ill. in Fig. 5	13,625 lb.	None	13,625 lb.	$ 933	6.7c in any quan.

*Based on casting at 5.6c per lb. and plate at 2.5c per lb.

Fig. 5. Side of Base Having All-Welded Bearing Block.

(This differs from the construction shown in Fig. 4 in that the bearing block is not cast but is entirely welded. The all-welded construction has its greatest advantage when rapid delivery and a small number of units are involved. This base was assembled, welded, stress-relieved, cleaned, sandblasted and made ready for machining within 2½ weeks from the time drawings were released. An all-welded job moves rapidly during construction.)

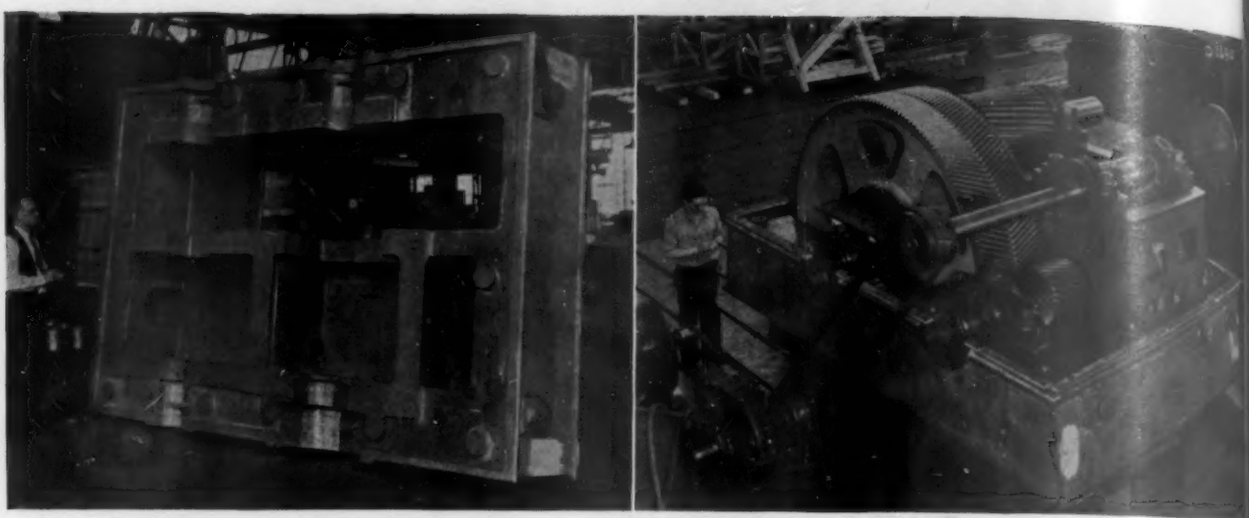


Fig. 6. Double-Reduction Finishing Scalebreaker Drive.

(These two views of the base, with and without gearing, show a combination of steel castings and welded steel plate. The boundary of the casting is plainly indicated in the right-hand view by the two welds running vertically just outside the high-speed and low-speed bearings. The base weighs 21,000 lb. and is 10x18 ft. by 3 ft. high. Tremendous power must be transmitted within the welded case. Although the factor of safety is great in order to insure rigidity to the structure, the importance of good welds must not be underestimated. Plates cannot be merely tacked together with a few light fillet welds. Important welds require scarfing the edges and welding all the way through. The number of welds is reduced to the minimum by using shapes flame-cut from plate whenever possible. It is the present practice to allow ⅝-in. stock for machining. However, even in a base of this size with heavy, continuous welds, ½-in. stock would probably suffice, as distortion is slight. The high-speed and low-speed bearings are contained in one casting, which is rectangular in shape and is carried down to the foundation. After machining, the oil pan is welded into the rectangular opening in the bottom.)

indicates that cast bearing blocks would probably cost about as much as the welded ones shown. But we will assume that minor factors enter and swing the choice definitely in the direction of cast bearing blocks.

Then, if castings are most economical for the bearing blocks, why not go further with casting? Why not join the bearing block together in one long casting? Why not make the whole side frame a casting? In fact, one might ask, why not make the entire base a casting? Let us see what actually happened when bases were made using almost all the possible combinations of casting and welding which were practical for a job of this type. Starting with an all-cast base, the amount of casting was decreased in the following steps until the all-welded extreme was reached:

1. All cast (Fig. 1).
2. Side wall and bearings cast in one piece (not shown).
3. Part of side wall and bearings cast in one piece (Fig. 6).
4. Two bearing blocks in the same casting (like left-hand bearing, Fig. 4).
5. Each bearing block a separate casting (like right-hand bearing, Fig. 4).
6. All welded (Fig. 5).

As we go down the list above, with the weight and size of casting in the base continually decreasing, let us notice what actually happened to the three important variables: (1) the total pattern cost, (2) the cost of the castings, per pound, and (3) the cost of the whole composite structure, per pound.

The pattern cost declined rapidly from about $1600 for the all-cast unit to $70[illegible] for the unit having small individual bearing blocks.

The cost of the casting dropped from 10 cents per pound down to about 6½ cents, contrary to the general principle that heavy castings should cost less per pound than lighter ones. This drop was attributed to the fact that the small bearing blocks were simpler to mold and had much less surface area to be chipped and cleaned than did the longer type of casting.

And finally, the cost of the composite structure dropped from 9 cents per

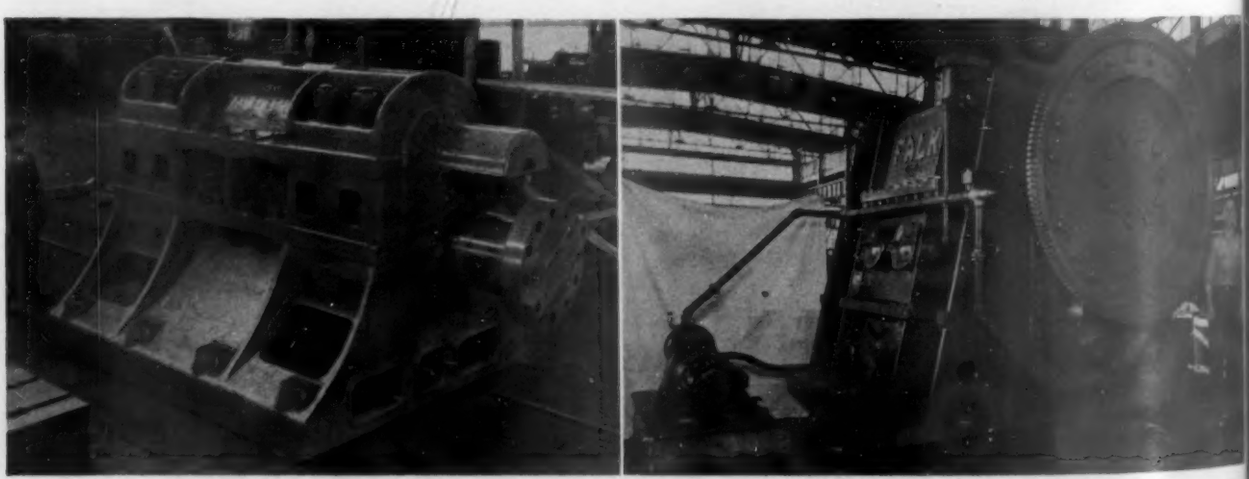


Fig. 7. Old-Style Cast-Steel Pinion Stand (Left) and New-Type Welded Pinion Stand (Right).

(That the cast-steel unit is strong and rigid enough has been proved in service, but a comparison of this unit with the welded pinion stand reveals some interesting contrasts. In the welded unit, which is larger than the cast unit, the centers of the shafts are 26 in. apart, compared with 20 in. for the cast unit, and the face width is 52 in., compared with 40 in. for the cast stand. Although it is larger and transmits more power, the welded unit is somewhat lighter than the cast stand, its weight being 40,200 lb., while the casting weighs 42,610 lb., these being the weights of the case only, without the gears. If in designing the welded pinion stand, the old casting had been copied and every inch of cast steel had been replaced with rolled plate, unquestionably the cost would have been higher than the original casting. The welded unit is much simpler in its arrangement than the casting which it replaced. For one thing note the absence of ribs and brackets.)

pound with the long castings down to 7 cents per pound with the small bearing-block castings. One must therefore conclude that the unit with small bearing blocks of cast steel was more economical than the other combinations which contained larger proportions (by weight) of steel castings. (For a brief comparison of this type of unit with an all-welded unit, refer back to the table.)

To further emphasize the cost advantage of small cast bearing blocks for steel-mill drives, the following figures are presented from shop cost records:

Five bases were made having the entire side wall and its bearings in a single casting. Patterns were changed to alter the center distances of each unit. The cost for patterns was approximately $4,000, and could have been reduced to $700 by casting a small individual bearing block for each bearing. Much of the saving lay in the fact that the latter may be placed at different center distances without a pattern change.

In combining casting and welding it can now be readily seen that costs must be the major consideration. The designer must investigate cost figures and work constantly toward the least expensive combination of casting and rolled steel plate which will adequately perform its function.

Five Principles Based on Shop Experience

The studies made of various combinations of casting and welding in making gear cases resulted in the adoption of the following principles:

1. Bases should be all-welded whenever single units or few units are to be made.

2. In quantities of six or more units, cast bearing blocks should be used if the same pattern can be employed for all the bases.

3. The use of castings should be confined to the making of individual bearing blocks—a separate block to carry each individual bearing.

Generalizing further, it may be said that:

4. Thin sections (up to 2 in. or 3 in.) which are large in area and can be made from a few simple elements such as flat plates, curved plates, square bars, structural shapes, rings or tubes, are natural welding jobs.

Fig. 8. Welded Pinion Stand.
(The cast-steel bearing blocks are set in between the two end plates and welded in place.)

Fig. 9. Small Combination Reduction-Gear Unit and Pinion Stand. Weight 15,000 Lb.

5. Heavy sections and parts of irregular contour having many recesses and projections are less expensive to cast than to weld. This is true only when quantities are large enough to spread the pattern cost over several pieces.

In concluding these notes a word must be said as to their accuracy. Data were taken from the shop costs of more than 50 large gear cases weighing between 15,000 and 50,000 lb., all manufactured within the past year. It was not practicable to take all the costs of these and group them to reach some kind of average figure for each type or for each different combination of casting and welding. They did not lend themselves to grouping, as there were too many variations in size and kind. For this reason individual examples were chosen. These appeared, in the writer's best judgment, to be representative of the group as a whole. Where figures are incomplete it was for the sake of brevity and no facts have been omitted which would change the conclusions in any way. Representing a company which has facilities to do both the casting and the welding of any of the products mentioned in this discussion, the writer has no reason to be prejudiced as regards either method of construction. Conclusions merely represent the writer's point of view based upon the experience which he has had in this rather new field of combined casting and welding.

Purdue Announces Annual Welding Conference

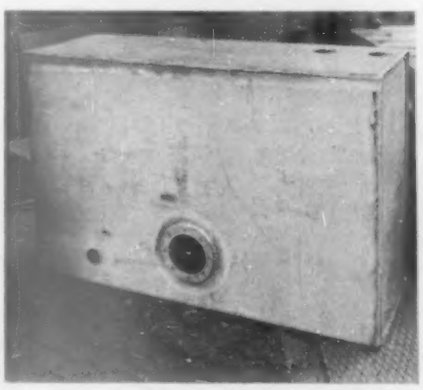
The twelfth annual welding conference at Purdue University, Lafayette, Ind., will take place on Thursday and Friday, Dec. 10 and 11, it is announced by J. D. Hoffman, director, department of practical mechanics. These conferences have been steadily increasing in attendance and in the interest and cooperative spirit shown. Last year 451 persons from off the campus were registered.

Welded Copper-Alloy Tanks Resist Sea Corrosion

Built to resist corrosion in marine service, 12 rectangular tanks for fuel-oil storage were recently manufactured by L. O. Koven & Brother, Inc., Jersey City, N. J., for the U. S. Coast Guard. These tanks are made of Herculoy, a copper-silicon-tin alloy; and each is 54 in. long, 19 in. wide and 36 in. deep, and made of 3/16-in. metal with baffle plates of ⅛-in. metal.

Tack Welded Baffle Plates.

The baffles are flanged on all four edges with a ½-in. lip and tack welded into position, dividing the tank into three equal sections. The upper half of the bent L-section of the outer shell is then fitted over the bent lower section, with the ½-in. flange of the short L-section on the outside of the straight front and rear faces. These are carbon-arc welded in one pass with ¼-in. Herculoy welding rod. The end plates of the tank are also flanged all around, inserted into the shell and likewise welded on all four edges.



Completed Tank With Welded-In Spud.

A drilled Herculoy spud is likewise welded into each tank.

Pittsburgh Barge Plants are Busy

Building Welded River Craft . . .

By EDWARD H. SYKES
Pittsburgh Correspondent,
The Welding Engineer

BOAT and barge building plants in the great industrial area of Pittsburgh are working night and day as a result of the tremendous increase in freight movement, principally on the Monongahela River, along which some of the best metallurgical coal in the world is mined. As a result, there is a greater demand today for welded floating equipment than during the boom days of '28 and '29.

Some idea of just what is taking place in the way of river freight transportation may be gleaned from statistics rerecently released by Col. W. E. R. Covell, chief of U. S. Army Engineers of the Pittsburgh district, who disclosed that July freight tonnage on the Monongahela River totaled 2,564,444 tons — within 206,000 tons of the record peak of the Panama Canal. In addition, a large but lesser tonnage is moving down the Allegheny River which, with the Monongahela, meet at the "point" in Pittsburgh's "Golden Triangle" to form the Ohio River.

Coal Movement Largest on Record

The movement, consisting chiefly of coal from Pennsylvania and West Virginia mines, including the large captive pits of the steel companies, constituted a record high to date. The highest previous total for the Monongahela was recorded in March, 1927, when 2,529,828 tons moved. The present tonnage is larger by approximately 100,000 tons than the latest available statistics, for comparative purposes, from the Panama Canal.

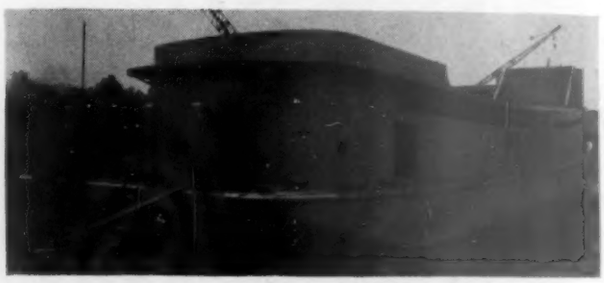
Such vast water freight movements require enormous amounts of equipment such as barges, tow boats, dredges, scows, cranes, etc. Significantly, the trend is unmistakably toward welded specifications in the construction of this vast steel tonnage.

In a previous article, the writer told of the huge river expansion program of the Campbell Transportation Company of Pittsburgh, a John W. Hubbard interest, headed by Charles Campbell, president. "Charlie," an enthusiastic welding advocate, personally told this writer that he favored welded construction, and that all future commitments for equipment would carry welded specifications. The Campbell organization, which has spent upwards of three-quarters of a million dollars in the past year for river floating equipment, is by no means finished with its expansion program.

And now the giant Pittsburgh Coal Co., Mellon-controlled organization, is embarking on an expansion program which calls for an immediate outlay of approximately $1,000,000 for inland-waterway equipment, a very large portion of which is to be all-welded equipment, including ten welded barges recently delivered by the Treadwell Construction Co., of Midland, Pa., as disclosed in a recent issue of *The Welding Engineer*.

In order to facilitate movement of its great tonnages, the Pittsburgh Coal Co. has found it advisable to modernize and rehabilitate several of its steamers, among them the *Cruiser* and *Ranger*, sister ships, and this work was inaugurated by the Dravo Contracting Co., of Pittsburgh, on its Neville Island marine ways.

The accompanying illustrations show how the welded steel hulls and superstructures were erected for these steam-



Welded Steel Hull and Superstructure for Pittsburgh Coal Co. Steamer "Cruiser".

Fabricating Welded Steel Hull for Steamer "Ranger".

Hull of Towboat "Winnie Mae."
(This welded craft measures 90x22 ft., and has a 5-ft. draft.)

Finished Hull of "Winnie Mae."
(The boat will be operated by the Monongahela & Ohio Dredging Co. of Pittsburgh.)

ers by Dravo welding engineers. Shop assemblies followed, one right after the other, on the marine ways. These vessels are 145 ft. long, 32 ft. wide and 6½ ft. deep. Each involved approximately 250 tons of steel and took five months' time for erection.

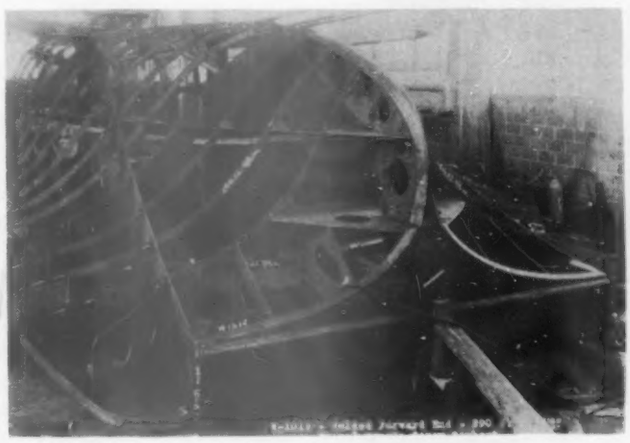
Another interesting sidelight in this mammouth expansion program of Pittsburgh Coal is indicated by the growing activities at its river terminal at Smith's Ferry, Pa., across from Midland, on the Ohio River. Here, the Dravo Contracting Co. recently erected a large whirler crane, which lifts the coal from barges into the Pittsburgh Coal Co.'s own railroad cars, moving over its own road, and the coal is delivered chiefly in the Youngstown district. Strange as it may seem, the Pennsylvania Railroad blocked this movement for years, notwithstanding the fact that one or two of the coal-company directors are also directors of the Pennsylvania. But the Pittsburgh Coal Co. won its case in court and is moving right along on its expansion program.

New Welded Towboat "Winnie Mae" Will Ply Allegheny River

Another interesting river development has to do with the expansion program of the Monongahela & Ohio Dredging Co., of Pittsburgh. This company, which performs a vast amount of work for the United States Government as well as private enterprises, recently called upon the Dravo Contracting Co. to fabricate a welded hull for its new towboat, *Winnie Mae,* which is to ply the Allegheny River.

The hull, of all-welded construction, was launched in March of this year. Two of the accompanying illustrations indicate different stages in the welding operations as fabrication proceeded on the marine ways. The hull is 90 ft. long, 22 ft. wide and 5 ft. deep and draws 3½ ft. of water. The large angles were bent hot and the duplication of frames was accomplished by jigs. The small assemblies were all made up in the Dravo shops and then welded together on the ways.

The *Winnie Mae* is being used to tend dredges and take away dump scows. It has a wooden superstructure and is equipped with a 300-hp. Fairbanks-Morse engine, driven through a gear reduction to the stern paddle wheel.



Welded Forward End of Towboat "Pioneer."
(Welded construction of watercraft framework effects economies impossible by riveting. Welded construction is by far the most durable in ships, boats and barges.)

In order to facilitate movement and expedite handling of river equipment business, it is necessary for the Dravo organization to operate a large fleet of its own, and they now employ upwards of two hundred pieces of floating equipment among the parent and subsidiary companies. A splendid example of welding, as employed in their own equipment, is illustrated in connection with the construction of the towboat, *Pioneer,* which was built recently for general construction work on locks and dams and for towing barge loads to dam sites. It is a smart-looking little tug, with a welded forward end, and is equipped with a 250-hp. diesel single-screw engine.

The outlook for continued good business among the boat and barge builders is very favorable; and regardless of the outcome of the election in November, these large fabricators of welded equipment have sufficient orders on hand now to keep shops operating well into next year, even if no additional orders were received.

The great pick-up in the giant steel industry of the Pittsburgh district has had a pronounced and favorable effect on practically all types of business. Inventories today are unusually low, and should there be a mad scramble for equipment, which might happen after the November election, the relief and employment problems will be taken care of automatically.

250-hp. Single-Screw Diesel Towboat "Pioneer".

Successful Metal Coating by the Spraying Process . . .

By DR. LEOPOLD PESSEL
Technical Director, Metals Coating Co. of America.

PAPERS dealing with the sprayed molten-metal coating process are nothing new to the readers of this journal, and a knowledge of the general principles underlying this process might well be assumed. Quite characteristic of most of these papers is a note of enthusiasm which, however, may not be exactly the proper background for a cool and deliberate judgment of the process and its economic value. Very few of the jobs described have been in service a span of time sufficiently long to serve as definite proof of success.

Every one familiar with metal coating knows too well that almost anything "can be done" with sprayed metal but, provided he is honest, we will recall a not insignificant number of "un-doings," or in plain language, failures. If a few principal characteristics of sprayed metals are kept in mind, some otherwise tempting jobs may be turned down, but there will be few failures. The purpose of this paper is to discuss these fundamental principles and to illustrate their practical application with a selected number of typical and time-proven jobs.

Sprayed Metal Is Not "Similar to Cast Metal" in Properties

It is about time that the frequently made statement of the physical properties of sprayed metal being similar to those of "cast metal" is met with emphatic denial. Such a comparison may well prove to be dangerous and misleading. It is true that some metals and alloys are available in cast form only, due to their brittleness and lack of ductility, strictly explainable by their chemical and metallographic characteristics. Cast iron is a notable example, pure chromium is another one. However, the tensile strength, elongation and ductility of the large majority of metals and alloys in cast form are far superior to the corresponding properties of those metals in the form of sprayed deposits.

Coatings Built Up by Partial Fusion and Interlocking

The latter are built up by interlocking and *partial* fusion of the tiny molten metal particles, issuing from the spraying tool in the form of globules, but flattened, shattered and torn to irregular shapes by the impact. Typical stratified layers may be observed in photomicrographs prepared from such deposits. The tensile properties of the original metal might still be present within each individual particle entangled in a maze of millions of similar ones. But the tensile strength, ductility and elongation of the resultant deposit is governed by the physical structure of the whole. Stratified structure, presence of oxides, absorbed gases, voids between the particles, are deciding factors which outweigh the physical properties of the original metal wire used. The individual metal droplets may be cast metal, but it is wrong to apply this term to the whole deposit.

As far as tensile strength, ductility and elongation are concerned, it is far better to play safe and neglect them completely in sprayed metal coatings. In other characteristics, however, such as hardness, compressive strength, wear resistance, corrosion resistance, heat and electrical conductivity, etc., the properties of the original metal wire may have been modified if well understood and applied, but they still exist to an extent sufficient to be of value.

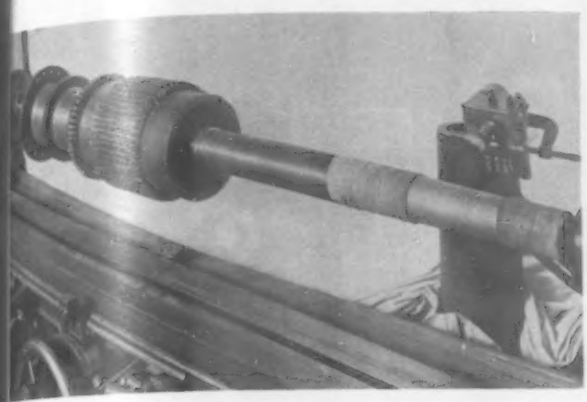
If a comparison with some other form of metal structure is to be made, it is suggested to drop that with cast metal and to remember the important family of products of powder-metallurgy, such as stellite, etc. The original powder form of the basic constituents, the role of heat and pressure instrumental in their production, the hardness and brittleness of the resultant metallic bodies, all are factors justifying the claim of distant kinship between sprayed metal deposits and that valuable group of modern tool materials.

Sprayed Metal Found To Be Partly Pervious

From the description of the physical nature of sprayed deposits, it is obvious that they must be assumed to possess a certain perviousness. This, however, cannot be compared with the porosity encountered in other types of metal coatings, such as chromium plating, hot-tinning, etc. In these latter coatings, the pores are open discontinuities which readily offer access to corrosive agents

Sprayed Molten Lead Protects Battery Chambers of Submarines.

(The battery compartments in submarines are subjected to the most severe type of corrosion due to the simultaneous action of sulphuric-acid fumes, moisture, sea salt, oil fumes, etc. About 11 years ago the Peruvian Government had the bottoms and walls of the battery chambers in a number of new submarines coated with a layer of sprayed molten lead, approximately 0.03 in. thick, followed by a top coating of bakelite varnish. A decade of trouble-free service proved the effectiveness of the coating. In the course of a recent inspection the original coating was still found intact in most places, except where it had been damaged by the handling of the heavy batteries. In view of the satisfactory performance of the original coating and the necessity to eliminate even minor pitting and corrosion in this important section of the boats, the Peruvian Government decided to renew the complete coating in all battery chambers. Eleven years of service under such extremely severe conditions would seem to be a test of sufficient length to prove the protective qualities of sprayed molten lead.)



Typical Mechanical Applications, Consisting of the Building Up of an Armature Shaft and Reconditioning of a Worn Crankshaft.
(Such applications have proved of particular interest and attraction to the welder because they extend his activities into what was formerly "forbidden land." In work of this character, the surfaces to be built up are taped off (shielded) to protect the adjoining areas, then blasted with angular steel grit and then sprayed with high-carbon steel (approximately 0.95% carbon) to approximately 0.020 in. above the finished dimensions. Finishing is done by wet-grinding. The number of worn or undersized surfaces built up in this manner within the past few years can hardly be estimated, but this method has become universally recognized standard procedure.)

and which quickly become centers of local galvanic cells, causing pit formation. In sprayed metal deposits such open discontinuities are not to be assumed, but rather the possibility of a gradual permeation through the complicated network of stratified layers constituting the sprayed deposit. If such penetration takes place under conditions favoring electrolytic action between base and sprayed coating—specifically speaking, if the coating is cathodic towards the base—the effect of such action is likely to be the breaking of the bond and the separation of the coating from the base.

Fortunately, there exist three principles which, under practical conditions, serve to counteract the natural permeability of sprayed coatings.

The first is based on the fact that some metals, such as zinc, aluminum and cadmium, are so reactive, especially when used as coatings on iron or steel against which they are ordinarily anodic, that any interstices existing within the coating are quickly and effectively filled and sealed with the corrosion product of the sprayed metal itself, producing an insulating and protecting film on the deposit.

Sealing Material May Be Used to Fill Pores of Sprayed Metal

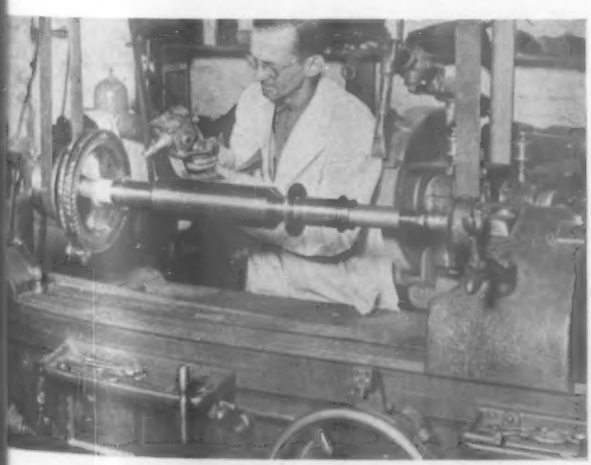
The second method utilized in special cases is the impregnation of the coating with an inert sealing material, such as paraffine wax, synthetic resins, etc., or the application of a top coating, such as bakelite varnish.

The third method is based on the principle that with increasing thickness of a sprayed coating its perviousness diminishes rapidly. At a certain thickness, which varies with the metal, the coating can be considered for all practical purposes impervious.

By knowing and utilizing these principles it has become possible to use sprayed metal coatings over a wide range of applications, with complete disregard of any porosity that might be assumed theoretically.

Leaving out of consideration those special cases where metal coatings are applied on non-metallic bases, and concentrating on the far more extensive field of coating metal surfaces with metal, we find that blasting with sand or steel grit has retained its original position as the best form of surface preparation. To be sure, rough-threading may serve the same purpose in the relatively limited number of cases where heavy masses of metal are piled up on a shaft; but in probably 90% of all metal-coating work, blasting is used to prepare the surface.

The still popular misconception that the purpose of blasting is merely to clean should be dispelled. Without denying the necessity of removing all dirt, scale, old paint, or other material that may interfere with intimate metal-to-metal contact, stress should be laid on the great importance of the peculiar shattering of the metal grain by the im-



Coating a Turbine Shaft With Stainless Steel.
(This particular application is a connecting link between the field of corrosion prevention and that of building-up work. On the turbine shaft shown, the surfaces coming in contact with the carbon packing rings are subjected to severe mechanical wear and corrosion. Some years ago it was decided to coat these sections by spraying with stainless steel of the 18-8 type, followed by grinding to the accurate finish required. The results were so satisfactory that a number of these coated shafts have been placed in service, all giving perfect performance.)

Alumetized Racks.
(For many years a first-class eastern seaboard railroad has alumetized the racks used for heat-treating the side springs of locomotives to protect them against quick deterioration caused by the scaling effect of the hot furnace gases. By coating the racks with sprayed molten aluminum, followed by a furnace treatment which alloys the aluminum with the steel base and provides a highly refractory layer of iron-aluminum alloy, the life of these racks is extended many times beyond its normal span.)

Cast Pump Casings Before and After Being Sprayed With Molten Zinc.

(The density and imperviousness of the zinc coating is successful in overcoming the porosity of these castings, which was the source of annoying sweating and corrosion. For several years the company using these castings have made it a practice to coat them with a layer of sprayed molten zinc approximately 0.008 to 0.01 in. thick, thus eliminating all complaints. Sprayed zinc is considered today the most efficient and universally adaptable protection for iron and steel known. Hundreds of tons of zinc wire are used each year for the protection of most every kind of ferrous product, from bolt to battleship. Every passing year adds to the reputation of permanent protection at low cost established for sprayed molten zinc coatings.)

pact of the hard abrasive. This brings about the formation of a multitude of angular indentations and recesses, which not only offer anchorage to the impacted metal by "keying" action but, what is probably more important, enlarge the active contact area of the base and thus increase the natural adhesion forces active between two metal surfaces in intimate contact; as is well known, these forces may reach enormous values under proper conditions, which probably accounts, at least partly, for the strong bond between sprayed metal coatings and properly blasted surfaces.

Exception should be taken to statements made once in a while comparing this type of bond with that of electroplating. The physical conditions underlying the bond in either case are so utterly different that no such comparison should be drawn.

Another important factor is the grip action exerted by the shrinking metal deposit when building up shafts; this is the reason why in this type of work rough-threading may be substituted at times for preparation by blasting.

Overheating May Cause Failure of Coating

However, if the spraying has been done too fast, or the sprayed metal deposit has become so hot that it has lost its ability to shrink tight on cooling, a loose metal deposit will result. In coating flat or concave surfaces it is even more important to prevent overheating of the metal coating, because in such cases the contraction of the cooling metal may present a force superior to even the best of bonds. Particular precaution is necessary when applying heavy coatings or using metals of high melting point.

In 20 years of metal-coating practice, we have learned to eliminate the doubtful and the impracticable. The illustrations shown are a few typical examples indicating the great variety of work that has stood the test of time. In each case, the few fundamental principles discussed above were kept in mind, modified and adapted with a dose of common sense to meet each specific case. The process saved money for those using it and made money for those doing the work. If economic value can be defined by such simple words, then the sprayed molten-metal coating process has securely established its place.

Economies Effected by Early Repair of Manganese Steel

By B. H. PAYNE
General Manager, Stulz-Sickles Co.

While the reclaiming and building up of 11-14%-manganese-steel parts such as shovel teeth, jaw and gyratory crushers, pump shells, impellors, buckets, etc., effects economies, and such parts can be reclaimed and rebuilt by welding with nickel-managanese-steel applicator bars, wedge bars and welding electrodes cheaper than the cost of a new part, the fact is often overlooked that all these parts can be maintained at somewhat near their normal size and shape by welding with nickel-manganese-steel products and in that manner greater efficiency in their operation can be obtained.

Take, for instance, shovel teeth. They are designed to certain sizes to give the most efficient operation, but unfortunately 11-14%-manganese-steel shovel teeth are not hard when placed in operation; they are only tough. They obtain their hardness due to the impact and abrasion. But while they are work-hardening a considerable loss of metal occurs. Therefore, a shovel tooth that is 100% efficient the first day of its operation may several days later be operating at only 80% efficiency.

Originally, when wedge bars were first made, the demand was for wedges 4 to 6 in. long. But since then the operators of steam-shovel equipment have recognized the economies in early repair, and the demand is now for wedges 2 to 3 in. long. This holds true of crusher plates, gyratories and pump shells, and in fact

Dipper Teeth Rebuilt by Welding.

Tooth Retipped With Wedge.

all other parts of 11-14%-manganese steel.

The unfortunate part of using a jaw-crusher plate that has been worn down to a considerable extent is that a great part of the material passing through is not crushed to the correct size, and it is necessary to pass it through a secondary crusher, which overloads not only the screening equipment used but conveyors as well. This only adds to the cost of the material being taken out of the earth.

It is the writer's experience that many 11-14%-manganese-steel castings contain serious internal defects, such as weak metal caused by blow holes, etc. When these places are exposed, as a result of impact and abrasion, they wear away very rapidly; whereas, if these parts are rebuilt by welding with nickel-manganese steel the repaired section is by far the sounder piece of metal, for in order to replace the poor metal it is necessary to grind it out and replace it with weld deposit that is peened while hot, which gives a forged deposit in a manganese-steel casting, with consequent better resistance to impact and abrasion in the repaired section than is found in a new part.

Welding of these parts is cheaper

Steel Impellor Pump Reclaimed With Applicator Bars.

than purchasing new parts. The welded part very often lasts longer than a new part and effects economies in the operation of the plant, and very often saves delays of 4 to 6 weeks while the part is being shipped from the foundry.

While a good many plants which use 11-14%-manganese-steel parts are equipped with their own electric-welding facilities, those that are not are able to obtain service from their local welding shops, a great many of whom are now skilled in the art of repairing parts of this kind with nickel-manganese steel in its various forms. In the event no local welding shop is available with this experience, they can learn it very quickly, inasmuch as the repair of these parts is a simple process and does not involve a tremendous amount of skill.

While all of the repairs to 11-14%-manganese-steel castings should be done by arc welding and never by the oxyacetylene process, nickel-manganese steel is now obtainable in castings such as shovel teeth and other parts, and can be rebuilt economically not only by the electric-arc process but by the oxyacetylene process. As nickel-manganese steel is air-toughening, whereas Hadfield 11-14%-manganese steel is water-toughening, nickel-manganese-steel parts resist heat much better than Hadfield 11-14%-manganese-steel castings and consequently they can be rebuilt by either process with satisfactory results. If plants that are not equipped with arc-welding facilities, but do have a plentiful supply of oxyacetylene-welding equipment, would change their specifications to nickel-manganese steel, which has all of the general characteristics of 11-14% manganese steel, these parts could be repaired with their own equipment at only a fraction of the cost of new parts.

Reclaimed Tractor Treads.

Welding Solves Problems of Escalator Erection

By J. M. JARDINE
Western Welding & Boiler Repairing Co., Chicago

Up to five years ago available data showed that welded structures had cost slightly higher than those erected by other methods. This condition, I believe, has changed, especially on repairs and alterations, which have been the major part of structural welding during the last five years.

Welded Beam Connection Made Preparatory to Installing Escalator.

To explain the change in cost of welding, I will use the erection of an escalator in one of Chicago's large department stores as an example.

This particular job called for an escalator traveling from the sub-basement to the eleventh floor of the building. Before a decision could be arrived at as to methods of construction, numerous factors had to be taken into consideration—namely, elimination of erection noise, concentration of the work to as small an area as possible, and prevention of damage to plaster, frieze, etc.

Needless to say, welding solved the problem and in addition showed tremendous savings.

First, the area where the work was to be done was partitioned off, the partition being installed on center lines of the columns, giving an absolute minimum of waste space.

Beam Framed in to Column to Carry Additional Load of Escalator.

The next job was to dismantle the old connections, which called for the use of the oxyacetylene torch.

Then sufficient concrete and plaster were removed to permit the welding of shelf angles onto the columns. This, of course, was removed only from inside the enclosure. Had it been riveted construction, it would have been necessary to remove concrete and plaster from the opposite side of the columns, to say nothing of ruining the plaster, frieze, etc., when riveting.

The next economy was that of being able to do the work during the regular business day, the welding eliminating noise which could not have been permitted in the middle of a department store. This eliminated overtime pay rates.

Another valuable feature of this type of construction was that of holding all levels absolute. The escalators were shipped in shop-fabricated form and in no case was it necessary to use shims to line up the job.

New A. I. S. C. Specification Allows Higher Unit Stresses

Among the important changes in the new standard specification for the design, fabrication and erection of structural steel for buildings, issued by the American Institute of Steel Construction, are allowable unit stresses which accord in general with a basic strength of 20,000 instead of 18,000 lb. per sq. in. in tension. Changes have also been incorporated in sections dealing with bearing pressure on rivets, design of plate girders, and web crippling of beams.

Hard-Metal Applications Prove a Boon to Industry . . .

By D. E. STALEY
Sales Manager, Stoody Co.

HARD-FACING materials for application by the welding process were introduced about 15 years ago. At that time, welding as an industry was in its swaddling clothes. A welder in those days was something of a magician who could use a flame, and in some instances a metallic arc, to do a repair job that was too large or too intricate for the blacksmith to handle.

Hard-surfacing was not entirely unknown then, but the method consisted chiefly of surface hardening by heat-treating. The result was a hardness that was only skin deep and that did not last very long in hard service. So when hard-surfacing rods for application by the oxyacetylene flame and the electric arc were introduced, a new industry came into being. And with the new industry came more jobs for men who could learn the art of hard-facing.

Well-Drilling Bit Hard-Surfaced After Severe Wear.
(The small protuberances on the edges of the bit wings are tungsten-carbide inserts. The rough-looking surface of the wing bit is a coating of tube borium applied by the oxy-acetylene method.)

Hard-Surfacing First Used For Applications in Oil Fields

For a long time after hard-surfacing materials had been introduced to the public, their uses were confined chiefly to field applications. Manufacturers did not want to bother with them for several reasons, the chief one being that they did not understand how to apply the hard metals, and furthermore the application of hard metals to tools of any sort meant the loss of a certain volume of replacement sales.

The oil industry was the first to recognize the value of hard materials, probably because the rapid abrasion of oil tools slowed down drilling and made the drilling of oil wells a costly operation. A rotary drilling tool that lasted only a few minutes on the bottom of the hole, which might be anywhere from 500 to 5,000 ft. below the surface of the earth, meant only a little loss of money compared with the loss of time required to draw the tool out of the ground, replace it with another tool and then put the new tool back on the bottom of the hole again. A tool that could be made to last from two to ten times as long as an unsurfaced tool, meant the saving of thousands of dollars in the drilling of one oil well.

So when hard-facing came along, it was readily accepted by the oil companies and the drilling contractors. For several years, it was the practice of the small welding shops located near the drilling fields to do the welding and facing of all the drilling bits used by the oil drillers and contractors. Of course some of the oil companies had their own welding shops, but these, too, did all of the hard-facing on the bits after they had been purchased from the manufacturer.

The use of hard metals spread slowly to other industries. A few aggressive farmers tried hard-facing and told their neighbors about it. The application of a good hard-surfacing material to plow shares, cultivator shovels and other implements used in tilling the soil or gathering crops meant the saving of tool replacement costs as well as several sharpenings. Because the hard metal if applied only to one side of the plow or other implement, created a tendency for the tool to wear off more rapidly on the unsurfaced side of the tool, thereby causing it to sharpen itself as it was drawn through the soil, there was also a saving in power, whether feed for mules or gasoline for tractors.

Contractors using power shovels, dragline buckets, scrapers and other tools for moving and loading soil, sand, rock, gravel and other materials, gingerly tried hard metals on shovel teeth, bucket teeth, bucket and shovel bottoms, bucket lips and other wearing parts, with the result that the teeth and other parts could be made to last three times as long as unsurfaced parts, and sometimes longer.

Application of Stoodite to Coke Pusher Shoe.

Hard-Surfacing Increases Life of Rock Crushing Machinery

The rock-products industry, including cement mills, tested hard-surfacing materials on crushing as well as excavating equipment and other machinery receiving heavy wear, with the result that the lives of the machines or machinery parts were extended two or three times the life of the average unsurfaced part.

The mining industries generally employ the same sort of equipment used by contractors and rock-products industries, and many of our greatest mining

Road Ripper With Hard-Surfaced Teeth.

(The teeth are faced with tube borium, which gives them excellent protection when tearing up oil roads or asphalt pavement.)

concerns have adopted hard-surfacing applications as standard plant practice.

The steel mills have learned in recent years that hard metals not only make it possible to conserve their equipment for a much longer time, but by their use steel-plant operators have been able to do certain things in metals that were once considered almost impossible. On roll necks, guides, wabblers, rolls, shears and dies, hard metals are used very extensively, and the application of hard metals has made it possible to accomplish results that were not considered practical before the introduction of hard materials.

Ultimate Consumer Profits Most from Hard-Surfacing

It is a well-known fact that the man who profits most from the use of hard metals is the ultimate consumer or user of the tool having hard metal applied to it. Thus the farmer with a hard-faced plow share that can do a year's plowing without the expenditure of another cent for plow shares or sharpening has been known to save as much as $30 to $40 on his investment in a single hard-surfaced plow share. The oil-tool operator who has reduced his bit cost from 50% to 75%, as well as the cost of frequent withdrawal of the tools from the hole, probably profits most of all from hard-metal application. The contractor who saves half the cost of his shovel teeth and other working parts by the use of hard metals knows that hard metals are one of the greatest saving factors in connection with his work. The same things could be said about rock-products industries, cement plants, and probably more than anywhere else except in the oil fields is the saving from hard-facing metals noticeable in the steel and metal-working industry.

The reasons why the use of hard metals has not been adopted generally wherever abrasion occurs can be summarized as follows: (1) lack of knowledge of proper application by welders; (2) refusal of manufacturers to adopt hard-surfacing metals as a part of their standard equipment.

Hard-surfacing applications, although made by welding, should be considered as welding variables that must be given special attention if best results are to be had.

There are literally thousands of good welders who can make strength welds with all sorts of bare and coated rods; who can braze or weld cast iron, copper, bronze and aluminum; who can make all sorts of repairs on equipment that could not possibly be made otherwise. Yet these same welders might not be able to do a good job in hard-surfacing because of lack of experience in applying hard metals. Probably one of the reasons why many welders can not do a good hard-surfacing job is because the cost of hard-facing metals is too high for the welder or his boss to obtain sufficient quantities to enable the welder to learn how to do a good hard-surfacing job.

Too Heavy Application Causes Occasional Failure

Hard-facing jobs sometimes fail because the hard metals have been applied too heavily. Some welders do not seem to understand that hard metals in themselves lack sufficient tensile strength to stand up under severe operating conditions. Generally speaking, thin layers of hard-surfacing materials work far better than heavy or even medium thicknesses of the same metals.

Other failures are easily traceable to the wrong kind of parent metal. Manufacturers of certain types of replacement parts have learned that certain specifications of steel do not readily lend themselves to hard-surfacing applications. Obviously, if the manufacturer wants to continue in the replacement business, he must supply a type of steel that can not be hard-faced, otherwise he stands to lose from one-half to three-quarters of his business. A welder who studies hard-facing applications should know the proper types of steels for hard-metal applications and should also learn to detect the sort of steel that will probably fail if hard-faced.

Loss of Replacement-Part Sales Handicaps Hard-Surfacing

Some manufacturing concerns have steadfastly refused to adopt hard-facing as a part of standard equipment because it would mean the loss of replacement parts. Thus a hard-faced plow share could be expected to outlast three new unsurfaced shares and consequently would mean the loss of two-thirds of the plow-share business. The same statement could probably be made in connection with many other types of manufacture such as power shovel and dragline buckets, as well as grader blades and scarifying teeth.

The first lot of manufacturers to adopt hard-facing applications as standard practice and equipment was the oil-tool industry, which soon learned that unless drilling bits and other equipment used in making holes in the ground were faced with some sort of hard metal, the business would go to concerns already using hard metals. So today no manufacturer of oil-well-drilling tools would think of selling a tool, except by special request, without having some sort of hard metal on it, any more than an oil-well-drilling superintendent would think of putting a tool in the ground without knowing that it was hard-faced before it went in the hole.

One enterprising road-machinery manufacturer whose business has grown tremendously during the depression undoubtedly owes his success and prosperity to hard-surfacing applications. It is

Application of Borod to Bottom of Ploughshare.

said that this manufacturer never uses a tool or allows one to be rented or sold without first having hard-surfacing applied in the proper places.

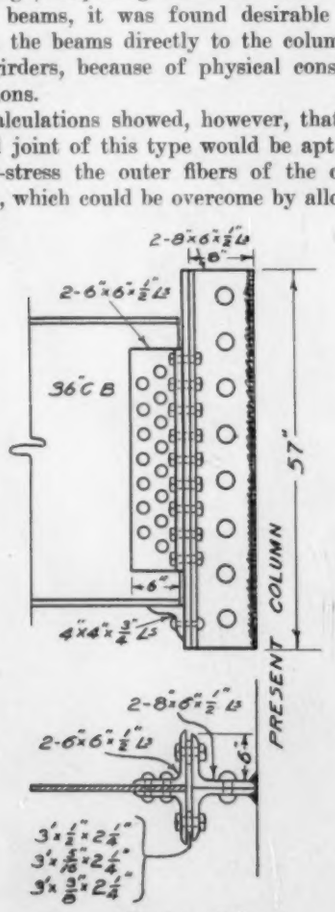
There are other manufacturers, including makers of coal-mining equipment, who supply many of their drilling and cutting tools with hard metal applied at the factory. The hard metals are recommended to their customers and, wherever necessary, instructions are given for the repair of the worn equipment and for re-hard-facing where possible. Undoubtedly other manufacturers will fall in line as time goes on until eventually all new machinery sold to the ultimate consumer will be properly hard-faced. When this time comes, there will be a tremendous demand for welders who can apply hard metals in the manufacturing plants as well as in the field shops where the worn parts must finally be reconditioned and hard-surfaced all over again.

Hard-surfacing has made a place for itself in almost every worth-while industry in the world. It is a business that has come to stay and one that offers great opportunities to welders everywhere.

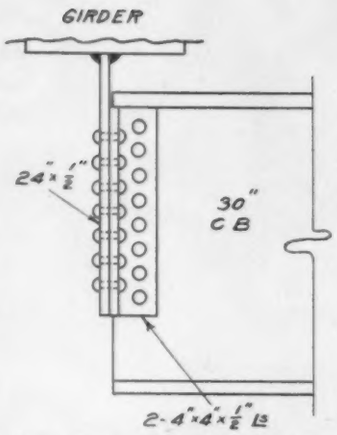
Flexibility Added to Welded Connection

In connection with the recent remodeling of a floor in the Tribune Tower, Chicago, requiring the installation of new beams, it was found desirable to weld the beams directly to the columns or girders, because of physical considerations.

Calculations showed, however, that a fixed joint of this type would be apt to over-stress the outer fibers of the column, which could be overcome by allowing more flexure in the design. This was accomplished by interposing a bolted and riveted joint at the ends of the beams, consisting of four angles assembled in the form of a cross, with two outstanding legs riveted to the web of the beam, the opposite two legs riveted together with the edges welded to the column face, and the other outstanding legs joined by bolts, with spacers between the legs.



Beam Affixed to Column.



Beam Suspended From Girder.

The legs at right angles to the center line of the column would give sufficiently under stress to permit a greater deflection of the beam under load than a strictly continuous type of beam-and-column connection would allow. Thus the beam acts more nearly like a simple beam, with resultant reduction in the bending moment introduced in the column.

Where the beam ends are supported from girders, the design consists of a 24x½-in. plate riveted to two angles, which are riveted to the web of the beam. The plate extends several inches above the top of the beam, and it is welded along its upper edge to the under side of the girder.

The structural steel on this job was erected by Nils J. Johnson & Co., 140 S. Dearborn St., Chicago, and the designer was Albert Smith, 307 N. Michigan Ave.

Extraordinary Exhibit of Metals and Minerals

The American Institute of Mining and Metallurgical Engineers, in cooperation with the Metal Products Exhibits, Inc., has assembled a most interesting and instructive exhibition which reveals the metallic elements present in the earth's crust, their availability, the locations of commercial sources and the flow of metals and minerals in world trade. Genuine ores, metals, and typical fabricated metal products, including specimens and displays supplied by State and Federal agencies as well as the major metal producing companies, will be shown.

This special exposition is being shown from Aug. 17 to Oct. 17 at the Metal Products Exhibits in the International Building at Rockefeller Center. Admission is free.

Armour Institute Announces Evening Welding Course

This year the Armour Institute of Technology, 47 West 33rd St., Chicago, Ill., will conduct a night school in welding, instruction being given two evenings a week. The course starts Sept. 28 and ends the latter part of May, extending through the entire school year. Students in the engineering school, and others, are eligible. Besides actual shop practice, metallurgy and other related subjects will be taught. Further information can be obtained from Dr. W. A. Pearl, of the Institute's staff.

This Handy Fender Tool Is Made by Welding

Welding makes this handy fender roller for the repair shop. The 1-in. tubing, three sections of which are 1 in. long, are cut sloping at the end and

How the Fender Tool Is Used.

welded into a square. One side-bearing and one thrust-bearing from an automobile are mounted on short shafts which slip into two sections of the tubing. A set-screw holds the smaller bearing, and allows it to be adjusted even with, or past, the other bearing. (The latter position is used in rolling the bead.) The side-bearing is moved in or out by a thumbscrew and threaded-bolt bearing against the back end of its shaft. In using this roller the repair man used a piece of old saw blade to distribute the pressure, and also to save the paint on the metal.

Miter-welding of square turns in pipe, quite popular some years ago, has been practically discontinued. Such joints are subjected to excessive stresses from expansion and contraction, and in addition offer frictional resistance more than times that of a rounded elbow.

Get "H. O. T." on Welding

By H. O. T. RIDLON

Have We Really Turned That Corner?

Out of the great Southwest comes word that pipe welders are knocking out a buck and a quarter to a buck fifty per hour. And there seems to be a shortage. In a small-town job shop down there, a job is open for a combination welder at 98 cents per hour. These small towns are swell places to live if you've come to the point in life when you think you'd like to settle down and take root. Perhaps plant a garden and weed it. In Cleveland the other day, getting away from the Mid-Continent section, I was told by my friend Eddie Scott that he had calls for more than thirty welders. And no one on hand to take the jobs. It sure looks like the gent that knows his stuff and wants to work can get all of it he wants. A young punk I trained a few years ago writes from Peoria (that's the town in Illinois where they make all the whiskey) that he's working steady with plenty of overtime taking him often into the yawning hours. And so from here, there, and yon come reports of work, more work, for Republicans and Democrats alike.

• • •

We All Can't Have That Job

Thanks to each and every one of you that sent me your application (there were twenty-five of you) for that job, which is, I believe is still open. All of you were swell. You all have about equal chances. My congrats to the guy that gets it. And my best wishes for much luck and success. If I can help any of you find another kind of a job, don't hesitate to write to the Old Maestro, telling me what you want, and I'll start the wheels a-rolling, and perhaps we can line up just the kind of job you are looking for, who knows? I am almost as versatile as a safety pin. Welders and particularly welding-shop owners have to be.

• • •

The Political Battle Front

Yes sir, all the boys that strain their conversation through a cigar are mighty busy these days, and what a grand mud-slinging party it is turning out to be. If you only listened to one side you would be very sure that the other gang were a bunch of so-and-so's as irrevocable as a haircut. None of them seem to choose an opinion but wear what happens to be in vogue. Recently there has been a lot of remarks over the radio by these boys about tolerance. They are telling us we must be tolerant, and that each of them will pull us out of this economic disturbance, depression or hard times to youse guys, for they are the kids that can perform the tenth wonder of the world. Well, I guess I'm like most people, because I am very sure that I am a very tolerant man, particularly when the other fellow agrees with me. But I believe I remember history right in that we have hard times, floods, strikes, wars, dry spells, corn-borers and whatnots almost without end, and that it wasn't one man or any group of men or women that got us out of our troubles. It was because we've pulled ourselves up by the boot straps that we came out of it O. K. And that's just what we are doing now. You see, I'm really going to make a grand president of the Fusion Party. Yes sir, this is about the last call to rally around my burning torch and support this cause.

• • •

Cataloged!

The other night in Cleveland the good wife and I were enjoying dinner with Bob and Mildred Kinkaid. I don't know what the girls were talking about, but Bob and I naturally drifted into talking shop. We weren't at it long when Mildred remarked, "They're welders first, and men second." So that's that. But I've always felt that nothing was work unless you'd rather be doing something else.

• • •

Ignorance Isn't Always Bliss

Sometimes we can't see the trees because we are too close to the woods. It seems that hardly a week passes that I don't visit a welding department in some large plant that is just downright careless in not knowing the hazards they ask their men to daily face. Oxygen and acetylene are swell servants, when properly controlled—but when they are turned loose, all hell can't stop them. One of the most outstanding cases of negligence recently came to my attention in a plant where they are doing a great deal of welding. The generator was over fifteen years old and not approved by the Underwriters' Laboratory. It was housed in the same room where the men were working. This room was so built, that should there be an explosion, the door would blow shut. It so happened that this generator leaked, as well as the pipeline. The torches were old and I watched one man operate for about an hour, and at regular intervals of approximately five minutes his torch flashed back. In the same room were the oxygen cylinders. It is altogether possible to visualize how there might be a severe flashback and an explosion under these conditions that would have made this room virtually a small San Sebastian that recently was blown up in Spain from a charge of a ton of TNT—but the reports from San Sebastian say that some men lived that were in this garrison. I doubt seriously if any man in this room would have lived should there be an explosion. Not only is this a terrific hazard of life and limb, but the wastes would pay for new equipment several times each year. In another welding department of the same plant, two out of three torches were leaking badly around the acetylene valve. It is a very simple matter for a man's clothing to become saturated with acetylene and ignite from a spark, causing a very painful and severe burn. Try this experiment some day. Put your cloth glove on your welding table. Put your tip on your glove, and turn on your acetylene for a fraction of a minute—then step away and throw a lighted match so that it lands on the glove—and watch the result. You'll understand then what might happen to your men, or yourself, if torches are used that are not kept in proper repair. It is not uncommon for a welding torch to consume fifty times its value yearly in the consumption of gas and labor. It is easy to waste 10% of this amount by using a torch that is obsolete or in poor repair. So you see how you can profit by watching these details—or consulting with someone who is a specialist in the use and control of high pressure gases.

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Do You Know That—

Rubber belting can be made into endless belts faster with the oxyacetylene torch than by the old process? It's a matter of minutes against hours. That's a service you can extend to the factories in your town that will bring in the bucks and build mighty good friends for you, because it is service like that, getting the plants rolling again quick when they might be down for hours or even days, that sets you in right.

In setting up a multiple oxyacetylene pipeline installation, you should have diaphragm line valves at each station and bursting discs at any change in the direction of the pipeline, and that it is wise to have condensation traps at each welding station?

In building up gear teeth, bronze is a most satisfactory material to use, no matter if they are steel or cast iron, because the finished job machines well and bronze wears well because the deposited metal is very dense?

Stainless steels can be very satisfactorily welded with the use of the oxyacetylene flame, but that you must have as near perfect regulation as possible, and a torch that will give you a long, concentrated flame that is soft?

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The thought for the month: If you won't be whipped, you can't be whipped.

Comparative Economies *of* Metal Electrodes . . .

III—Covered Electrodes

(Last of Three Articles)

By KARL MELLER

A NUMBER of heavily covered and asbestos-wound electrodes were tested in the same manner as bare electrodes. The melting rate for an electrode of the covered type, having diameters of 4, 6, and 8 mm. (0.157, 0.236 and 0.315 in.), plotted against the current is shown in Fig. 24. The weights given refer to the total weight of the electrode—that is the weight of the wire plus covering. Comparing Fig. 24 with the curves for a bare electrode in Fig. 3, shows practically the same relationship —that is, within certain current values, a straight-line increase with the current. In this case also, when certain current values are exceeded, deviation from the straight line occurs for each electrode size. Comparison, as far as it was applicable, showed that deviation from the straight line with covered electrodes begins at about the same current value as in the case of bare electrodes of the same contact length and diameter.

Fig. 25 shows the weights melted per hour for three covered electrodes having practically the same melting coefficients with different polarities. Further tests revealed that some electrodes have the same melting coefficient with positive and negative polarity, while, on the other hand, others have a higher deposit coefficient with one or the other polarity. The reason for this behavior is not known and further tests will be required for explanation.

Covered Electrodes Have Higher Melting and Deposit Rates

After all, the deciding factor in determining the economic value of arc welding is the weight of the deposited metal rather than the weight of electrode melted. The weight of deposit for one of the electrodes tested is shown in the lower curve in Fig. 26, while the upper curve represents the total quantity used up (metal and covering), and the middle curve shows the weight of the melted-off metal. The latter, at 150 amperes, amounts to about 1.6 kilograms

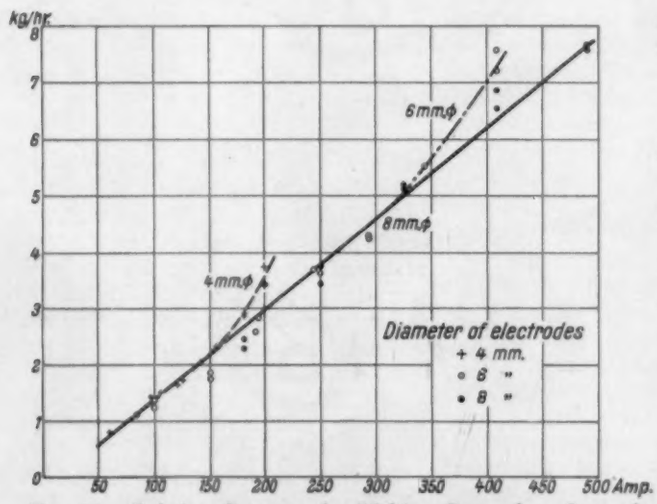


Fig. 24. Relation Between the Melting Rate of a Covered Electrode and Current Values for Three Different Diameters.

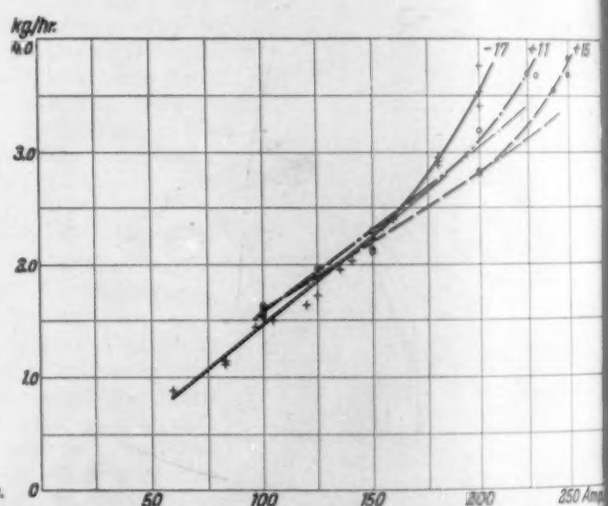


Fig. 25. Total Melting Rate of Several Covered Electrodes.

(The three different types of electrodes are numbered. Positive polarity is indicated by a plus sign and negative polarity by a minus sign.)

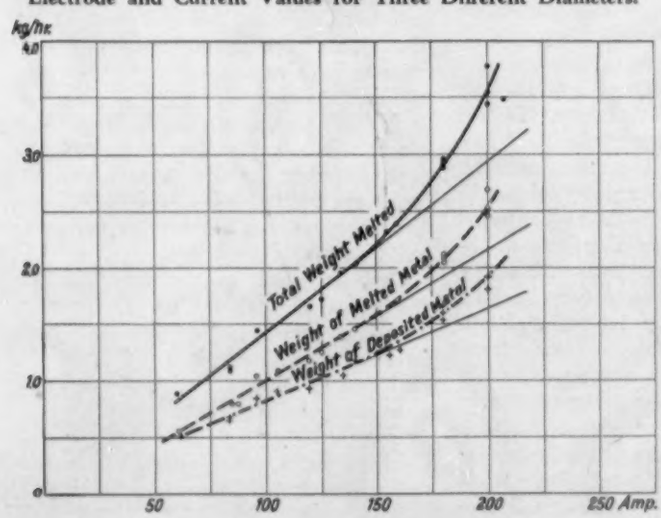


Fig. 26. Total Weight Melted, Weight of Melted Metal, and Weight Deposited per Hours, Plotted Against Current.

(Covered electrode No. 17, 4-mm. diameter.)

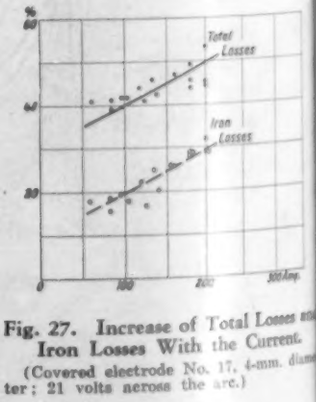


Fig. 27. Increase of Total Losses and Iron Losses With the Current.

(Covered electrode No. 17, 4-mm. diameter; 21 volts across the arc.)

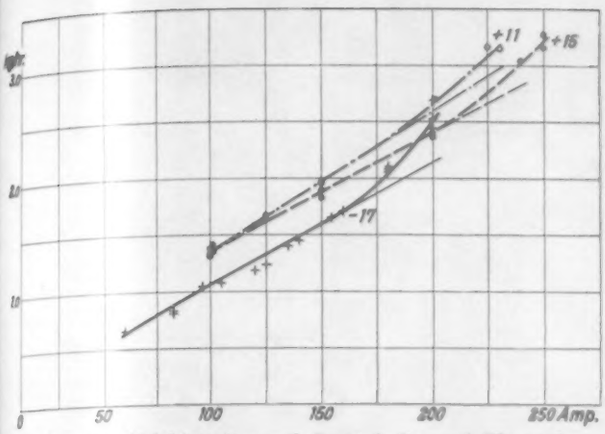


Fig. 28. Metal-Melting Rate of Several Covered Electrodes.
(The three different types of electrodes are numbered. Positive polarity is indicated by a plus sign and negative polarity by a minus sign.)

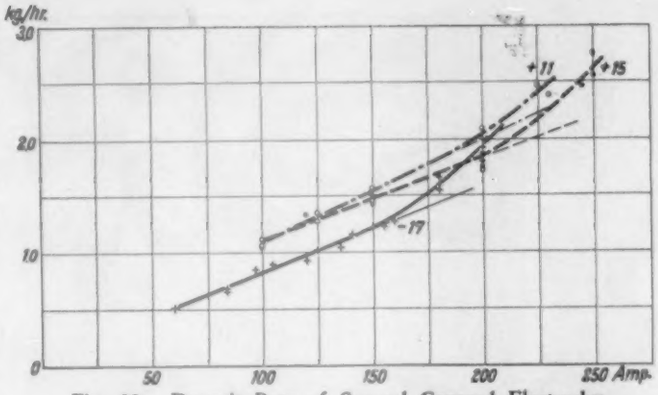


Fig. 29. Deposit Rate of Several Covered Electrodes.
(The three different types of electrodes are numbered. Positive polarity is indicated by a plus sign and negative polarity by a minus sign.)

(3.5 lb.) per hour, which is higher than the melting rate of 1.2 kg. (2.6 lb.) per hour for a corresponding bare electrode as shown in Fig. 8. The deposit weight per hour is also higher for the covered electrode as compared with the bare electrode, this being 1.3 kilograms (2.9 lb.) as compared with 1.1 kilograms (2.4 lb.). The relatively small difference between the deposited weights as compared with the considerable difference between the melted weights is due to the considerably higher spatter and other losses of the covered electrode.

Generally speaking, there is no clear conception in practice regarding the amount of the losses of covered electrodes and their dependence on current and voltage. Fig. 27 shows, for one type of covered electrode, the total losses expressed as a percentage of the total original weight, and also the losses due to evaporation and sputter as a percentage of the original weight of electrode metal, both plotted against current. The iron losses of various covered electrodes are not the same, but generally are higher than those of bare electrodes, which seems to be due to the higher arc voltage for the covered electrodes. In the melting of the electrode, the weight of the covering is almost a total loss. Measurements show that by far the larger part of the consumed covering is deposited on the material in the form of slag.

Polarity Affects Melting and Deposit Rates

The rate of melting of the electrode metal, plotted against current, is shown for three types of covered electrodes in Fig. 28. Although Fig. 25 reveals that the total melting rate is approximately the same for each of these three electrodes, the melting rate of the metal alone differs in this case with the polarity, as Fig. 28 shows. In Fig. 29 is shown the metal deposit rates for the same three electrodes, which in consequence of the metal losses is less than the values shown in Fig. 28.

It was further determined, by tests analogous to those with bare rods, to what extent the values in question depend on the voltage. Fig. 30 shows how total electrode melting rate and the deposit rate varies with the voltage. Attention is directed to the fact that the higher arc voltages and, consequently, arc lengths are of no practical value, but are important in examining the physical behavior of the electrode. Covered electrodes also show that, in general, same as in the case of bare electrodes, the melting rate is almost independent of the arc voltage, while the deposit rate drops owing to the higher iron losses occurring at the higher voltages.

Losses Are Greater at High Arc Voltages

The increase of total losses with arc voltage is shown in Fig. 31.

Oscillograms of the drop transition with covered electrodes are already

IN interpreting the illustrations in these articles, the reader is cautioned to observe that the "arc volts" represent the actual voltage across the arc, which is somewhat less than the voltage reading across the generator terminals.—Editor.

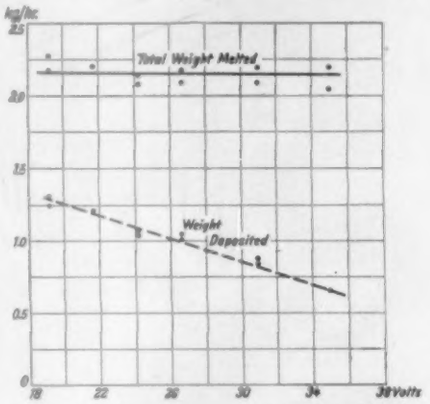


Fig. 30. Dependence of Total Weight Melted and Weight Deposited on Arc Voltage.
(Covered electrode No. 17, 4-mm. diameter; 140 amperes.)

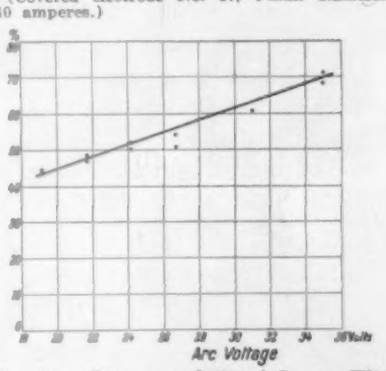


Fig. 31. Increase of Total Losses With Arc Voltage.
(Covered electrode No. 17, 4-mm. diameter; 140 amperes.)

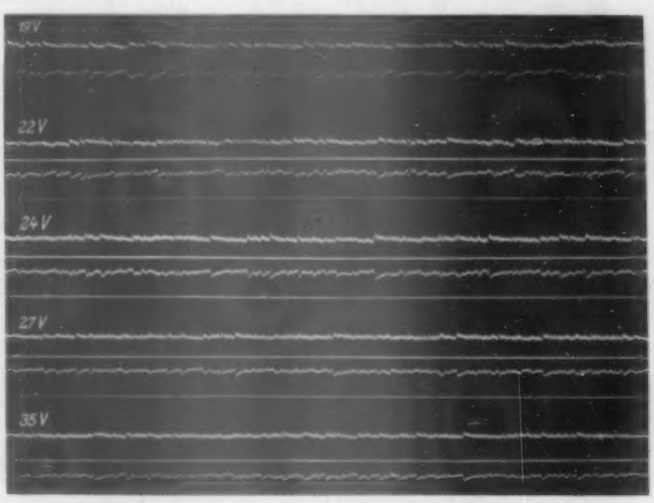


Fig. 32. Oscillograms Taken With a Covered Electrode at 140 Amperes and Various Arc Voltages.

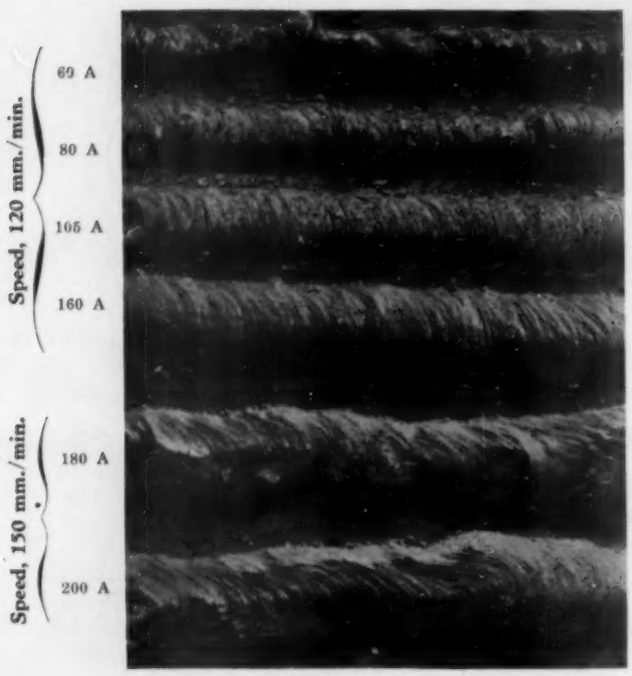


Fig. 33. Weld Beads of 4-Mm.-Diameter Covered Electrode Made With Various Currents.

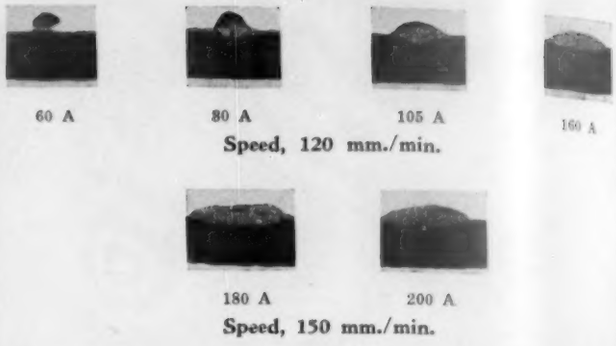


Fig. 34. Penetration of 4-Mm.-Diameter Covered Electrode Welded With Various Currents.

known. Fig. 32 is therefore intended only to show the oscillograms of current and voltage at different voltages. A comparison with Fig. 12 shows that the oscillograms with the bare electrode at 21 volts and those with the covered electrode at 22 volts show very similar characteristics. In the case of the covered electrode this voltage is normal, while with the bare electrode it corresponds to an abnormally long arc.

Determining Highest Current Density for Satisfactory Welding

Investigation was also made to determine the highest current density at which satisfactory welds could be obtained, with covered electrodes. Fig. 33 shows beads made with various current values, all at about the same speed. As with bare wires, the appearance of the beads is best at a certain current value, which in this case appears to be 160 amperes. The beads made at higher currents show an increased spreading. The higher values of 180 and 200 amperes lie, in fact, above the point where the curve of the melting rate deviates from the straight line, as seen in Fig. 24. Comparison with the bare-electrode beads shown in Fig. 14 shows that under test conditions the bare electrode produces a smooth bead at higher currents than the covered electrode.

Fig. 34 shows the slides of the weld beads disclosed by illustration 33. The spreading of the covered-electrode deposit and the greater disturbed zone of the parent metal with increasing current intensity, are shown in Fig. 34, which are the sections of the weld beads illustrated in Fig. 33.

Fig. 35 shows that an increase in voltage results in poorer beads and most probably also an inferior weld. At any rate, the beads continue to assume a flatter form.

Power Consumption of the Arc Does Not Vary With Current

The power consumption of covered electrodes also measured in a manner similar to the one employed with bare electrodes. If we assume that the same conditions obtain in both cases, the power consumption per unit weight of metal should grow in proportion with the higher arc voltage of covered electrodes. The higher welding speed obtained with some covered electrodes will compensate for this factor within certain limits. The values obtained for one such electrode are shown in Fig. 36. The upper line represents the power consumption per unit weight of electrode metal melted, which values are about 40% higher than those given in Fig. 20 for bare electrodes. If we assume the losses in the welding set to be the same, the power consumption will be correspondingly higher for covered electrodes. The power consumption of the arc is virtually constant, regardless of current, as may be seen from Fig. 36. But the power consumption in the circuit external to the arc will become greater with increasing currents because of the losses in the cables.

Comparison between covered electrodes in relation to one another, for economic purposes, is more difficult, in a way, than between bare electrodes, inasmuch as covered electrodes show marked differences in price, thickness of the covering and welding speed.

The ratio of the deposited weight to the weight of electrode melted, for a number of different covered electrodes, is shown graphically in Fig. 37, which

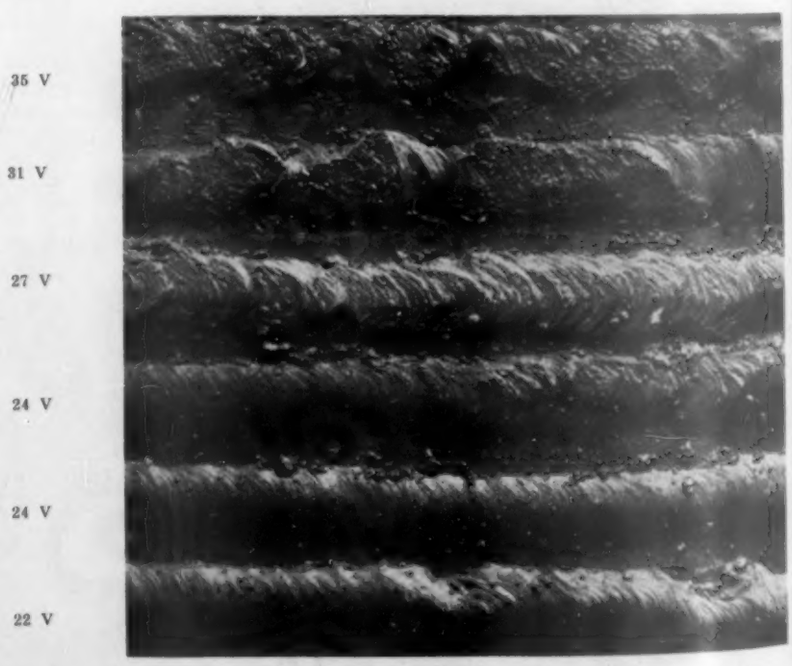
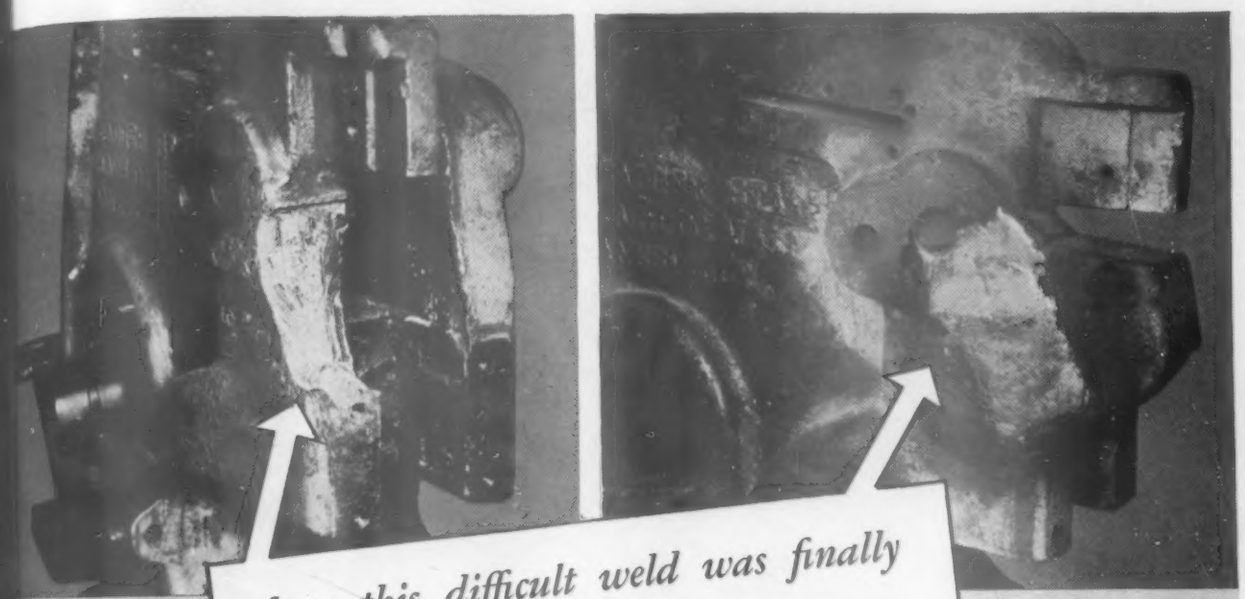


Fig. 35. Weld Beads of 4-Mm.-Diameter Covered Electrode Made at Various Arc Voltages.

"It couldn't be done"
...but Tobin Bronze did it



The fractured casting of the shear

how this difficult weld was finally made with

TOBIN BRONZE

The casting AFTER the repair weld had been made with Tobin Bronze

A WELDING firm was given the job of repairing the fracture illustrated above in a casting of a shear 3″ thick. It was planned to make the repair weld with cast iron rods. However, detailed inspection of the job revealed that, if this method were used, the size and weight of the shear would make it necessary to heat the entire casting in a furnace to avoid uneven strains in the metal.

This was given up as impractical because, after being preheated, the casting would have thrown off so much heat that no one could get close enough to work on it. In desperation, the shop owner called upon a rival company which specializes in Tobin Bronze welding.

The repair weld was made in 3½ man-hours, including an hour's time required by one man to clean up the weld area with a chisel. The weld area was preheated with one torch while the welder deposited Tobin Bronze with another. The two men spent 1¼ hours on this work.

This is just another case where Tobin Bronze did an otherwise impossible job, thereby saving the cost of a new casting.

• • •

Time-tried Tobin Bronze carries the trade-mark "Tobin Bronze Reg. U. S. Pat. Off." on each rod. Look for this mark and be sure you are getting the genuine product . . . *genuine* Tobin Bronze. 36294

THE AMERICAN BRASS COMPANY

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ANACONDA WELDING RODS

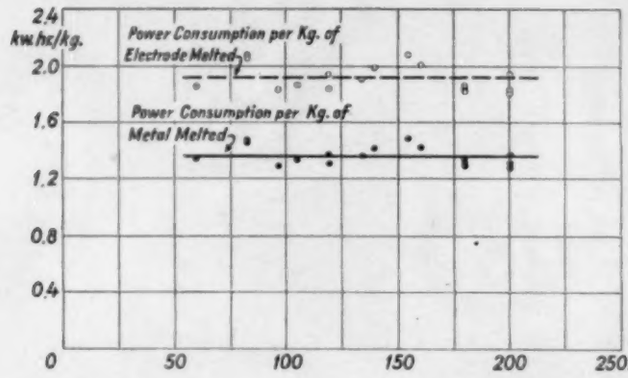

Fig. 36. Power Consumption at the Arc for a 4-Mm.-Diameter Covered Electrode.

gives the results of tests using equal current values and electrodes of the same diameter. Hence, the difference between the two values for each individual electrode, represents the total loss (slag and metal), which is seen to vary from about 48% to 30%, the average value being about 40%.

Fig. 38 furnishes another example of how electrodes can be compared, and shows clearly and in detail the influence of the covering and metal losses on the total losses. The first column for each type of electrode shows the weight of metal (taken as 100%) and the weight of the covering. The second column indicates the weight of metal deposited from the electrode. It is seen that the weight of the covering varies very considerably, ranging from about 16% up to almost 50%. The diagrams further indicate the metal losses as a percentage of the metal weight, represented by the difference between 100% (metal weight) and the value of the second column (deposited weight). These losses also fluctuate very greatly, varying between 9% and 31%.

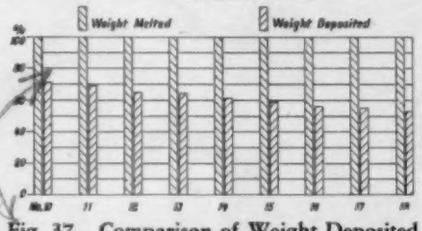

Fig. 37. Comparison of Weight Deposited With Weight Melted (= 100%), for Covered Electrodes at 150 Amperes.

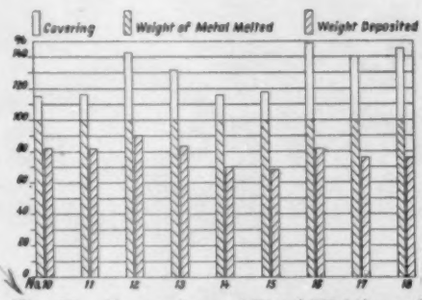

Fig. 38. Comparison of Total Weight and Weight Deposited, With Weight of Metal Melted (= 100%).

Deposit Coefficient Is Important Factor in Comparing Electrodes

This chart shows graphically the fallacy, when comparing covered electrodes, of merely using for a basis the price per unit weight of electrode including the covering. On the other hand it would be just as erroneous to use for comparison only the price of the electrode metal that is actually melted. On the other hand, one should consider the deposit coefficient, as this has a decisive bearing on the cost of labor and, after all, is the basis for determining the total welding costs.

When welding with covered electrodes, the ratio of electrode cost to labor cost is higher than with bare electrodes, and the electrode cost may be the greater of the two factors, unless the wage rates are very high. This is especially apt to be the case at high currents, since labor costs decrease with increasing current. Thus, while with bare electrodes the use of higher currents may under certain conditions considerably reduce the total cost, the amount of such reduction in relation to the total cost is less important when covered electrodes are used.

Whether the sum of the electrode and labor costs, which is the main factor in determining the economy of arc welding, is lowest when bare electrodes are used, or covered electrodes, will depend on the wage rate and the price of electrodes; hence, calculations must be made for each set of conditions.

MAGIC

By CLARENCE E. FLYNN

The farmer at his labor
On meadow, field, and sod,
Keeps coaxing life and bounty
From the responsive sod.
He works a potent magic
On earth's provision store.
He makes two stalks of wheat grow
Where there was one before.

The welder does his service
Of unremitting toil
Where industry is whirring,
Far from the springing soil.
He too is a magician,
Invoking learned lore.
He makes one piece of metal
Where there were two before.

Steel Engineers Convention to Have Welding Session

At the thirty-second annual convention of the Association of Iron and Steel Engineers, to be held September 22-25, in the Hotel Statler, Detroit, Mich., the following program has been prepared for the Welding Engineering Division on Thursday, September 24, 2 p.m.:

"Developments in Welding During 1935-36," by Grover A. Hughes, electrical engineer, Truscon Steel Co., Youngstown, O.

"Resistance Welding in Steel Plants," by Walter Anderson, vice-president, and Malcomb Clark, general manager, Taylor-Winfield Corp., Warren, O.

"How Arc Welding Aids in the Use of Standard Steel-Mill Products in the Electrical Industry," by O. A. Ti..., industrial engineering department, General Electric Co., Schenectady, N. Y.

"Commercial Welding as Applied in Steel Mills," by H. A. Woofter, engineer, Federal Machine & Welder Co., Warren, O.

Flash-Welder Jaws Improved by Hard-Facing

A company manufacturing ½-in. ... pipe couplings by the flash-welding process is now oxyacetylene welding a layer of Haynes Stellite to the jaw faces. The hard-faced jaws are said to last ...

Hard Faced Flash Welder Jaw.
(With hard-facing the jaws are said to last ten times as long as new ones of steel.)

times as long as new ones of steel. ... service is very severe. The jaws must grip the work, they must act as conductors of heavy currents, resulting in heating at their contact with the work and flying sparks of hot metal strike the jaws. Moreover, the finished work is quickly released while the jaws are still hot.

One great advantage of welded pipe over flanged and coupled piping in ... installations is that the former can be placed closer to ceilings and walls, or nested closer in tunnels, thus saving valuable space.

"COMPLETE SERVICE"

To plants using commercial gases, National offers a complete service—oxygen, acetylene, hydrogen, nitrogen . . . welding equipment . . . welding rods . . . cutting equipment . . . accessories . . . engineering service . . . quick deliveries . . . A phone call or a letter will bring complete details of this service to you.

See us at booth M 44, National Metal Exposition

NATIONAL CYLINDER GAS COMPANY

205 WEST WACKER DRIVE — CHICAGO • ILLINOIS

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LOGANSPORT - - INDIANA

Factory Directory

CHICAGO - - - - ILLINOIS
MILWAUKEE - - WISCONSIN
PEORIA - - - - ILLINOIS
ST. LOUIS - - - MISSOURI
LOS ANGELES - CALIFORNIA

THE PITTSBURGH GENERATOR CO., McKEESPORT, PENNSYLVANIA

What's New in Equipment and Supplies

New Glove Made Especially For Electric Welders' Use

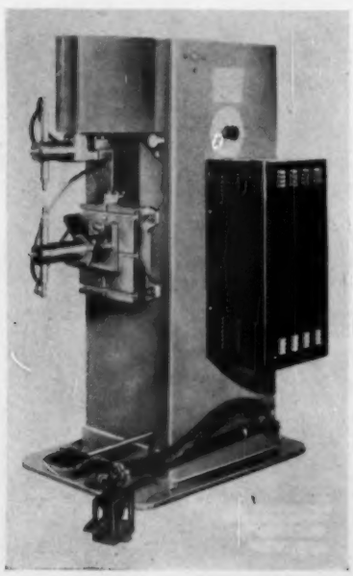
Operators of electric welders can now purchase a glove made especially for their use by the Frank Russell Glove Co., Berlin, Wis. This hand covering, known as the "Welder's Glove," is cut on patterns scientifically designed to fit the wearer's hand for the best protection. It has a large tab reinforcing and protecting the front of the operator's wrist, also double finger and thumb fronts with wide leather welt in thumb and forefinger. All seams are sewed with heavy four-cord glove thread, finger and thumb seams being double sewed. The material used is genuine split horsehide, a 7½-in. stiff split horsehide cuff being lined with heavy duck.

New Drop-Forged Regulator Announced by Torchweld

A new 2-in. 2-gauge regulator constructed entirely of drop-forged parts is announced by the Torchweld Equipment Co, 1035 W. Lake St., Chicago, Ill. Instead of the rubber diaphragm commonly used in small regulators, the new drop-forged device of the Torchweld Torchweld organization has a triple metal diaphragm crimped in place. This, according to the manufacturers, gives the regulator longer life with lower upkeep expense.

New Line of Eisler Spot Welders

Press-type resistance spot-welding machines are now available up to 250 kva. in rating and can be supplied in foot, motor or air operated models, says an announcement from the Eisler Engineering Co., 749 South 13th St., Newark, N. J. These machines are intended for handling various thicknesses of metal and are made in throat depths from 16 in. up to 48 in. They may be had with speed changes ranging from 30 to 100 welds per minute. The welder is a self-contained unit; that is, the timer, contactor and switch are all assembled in the welder.



Press-Type Spot Welding Machine.

Scale Gives Gas Costs for Welding Jobs

A "Welders' Standard Charge Scale," which converts drill-size gas consumption into dollars-and-cents charge for minutes of welding, is being sold by D. G. Dayton, of Will-Weld Manufacturing Co., Inc., Omaha, Nebr. The charges given are computed at 10c per cu. ft. of each acetylene and oxygen, which figure takes into consideration the cost of transporting cylinders at outlying points, also higher overhead at centers of gas distribution, plus a 25% profit on the gases. The chart covers both welding and cutting. A second chart gives the drill sizes of all standard makes of torch tips.

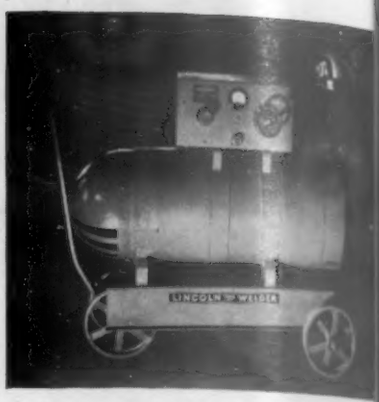
Arcoloy—A High-Strength Weldable Copper-Base Alloy

A high-strength alloy, called Arcoloy, now being used in the manufacture of range boilers and storage tanks, develops an average tensile strength of 55,000 to 65,000 lb. per sq. in. and is readily weldable by the electric-arc process, using Arcoloy electrodes, says an announcement from the American Radiator & Standard Sanitary Corp., 40 West 40th St., New York, N. Y., manufacturers of this new alloy.

Arcoloy consists of 95% pure copper with silicon, phosphorus and other elements added. It is said to have a higher resistance to ordinary corrosive agents than pure copper. Sulphuric, nitric and other volatile acids are said to have practically no effect on the metal. When used in the construction of storage tanks, the color harmony or the resemblance of Arcoloy to the copper pipe and fittings which connect it into the hot-water-supply system is said to have an immediate appeal to prospective customers.

Lincoln Announces New Dual-Control Welder

A new line of single operator arc welders, available October 1, is announced by The Lincoln Electric Co., Cleveland, Ohio. These new welders will be known as the "Shield Arc SAE" and will supersede the present type of



300-Ampere "Shield Arc SAE" Welder.

"Shield Arc" welders, which have been on the market for the last six years. The predominating feature of this new arc welder is a new method of arc control which makes possible the adjustment of both arc heat and arc penetration in a continuous sequence of fine increments. It is claimed this continuous dual control assures absolute uniformity of performance at every control setting.

The new welder retains all of the other design points of the former "Shield Arc" models, such as independent excitation, laminated magnetic circuit, all-purpose meter, polarity-reversing switch, no-voltage motor protection, etc. The base and portable parts have been redesigned for a more stream-lined effect and shorter wheel base.

The new "Shield Arc SAE" welders are available in the following types and ratings: A.c., motor driven, 200, 300, 400 and 600 amperes. D.c., motor driven, 300, 400 and 600 amperes. Generator for belt or couple service, 200, 300, 400 and 600 amperes. Engine driven, 200, 300 and 400 amperes.

"Layout Fluid" Gives Dark Background for Scribed Lines

"Layout Fluid," for application to the surface of metals which are to be scribed for any kind of work, has been put on the market by the Dayton Rogers Manufacturing Co., 1845 E. Franklin St., Minneapolis, Minn. "Layout Fluid" dries instantly to a dark-blue color, upon which the scribed lines stand out in strong contrast and can be followed more easily than when the metal is covered with copper sulphate.

New Shape-Cutting Machine Offers Many Features

A highly versatile shape-cutting machine is the new Oxweld Type CM-12, announced by The Linde Air Products Co., 30 East 42nd St., New York, N. Y. Simple or complicated shapes can be produced automatically with templets or by hand-guiding. The machine will cut straight lines as long as 144 in., at any desired angle, and an attachment enables the automatic production of circles

LEND 'EM YOUR EARS

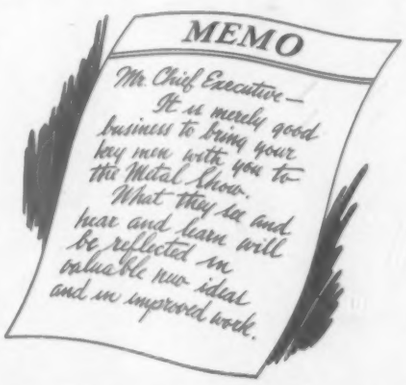
... AND HEAR THE YEAR'S 107 BEST METAL TALKS

THE metal man's annual opportunity to hear and discuss the work of outstanding experts in the metal industry, is provided at the National Metal Congress, to be held this year in Cleveland, October 19 through 23.

Programs of the five great national Societies participating in this year's Congress are studded with more than 175 technical and practical authorities from every branch of the metal industry. These men have cooperated to prepare 107 talks dealing with the latest news of metals and their use.

In the course of some fifty technical sessions, you will hear and discuss all phases of production, selection, fabrication, testing, inspection, treatment, welding and application of all kinds of metals. Sessions will be so arranged that programs will not conflict — you will have opportunity to hear the important talks on the subjects nearest your heart.

And please remember — the Congress is only half the attraction. The other half is the huge National Metal Exposition staged at the same time. Together they provide a great Metal Show that you dare not miss. The hundreds of exhibits, the exchange of ideas, the making of new friends and the meeting with old ones — all combine to bring you up-to-date and get you set for the year ahead. If you have not made hotel reservations, do so today and plan to attend.


MEMO
Mr. Chief Executive —
It is merely good business to bring your key men with you to the Metal Show.
What they see and hear and learn will be reflected in valuable new ideas and in improved work.

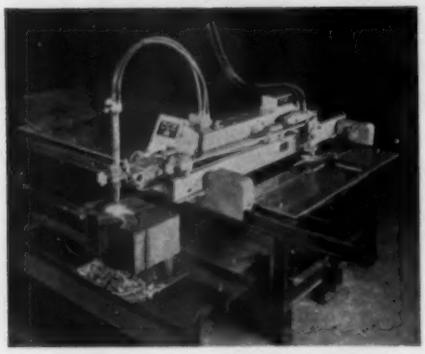
For complete details, write W. H. Eisenman, Managing Director, National Metal Congress & Exposition, 7016 Euclid Ave., Cleveland, O.

NATIONAL METAL SHOW

CLEVELAND, OHIO — PUBLIC AUDITORIUM — OCTOBER 19-23, 1936

COOPERATING SOCIETIES

AMERICAN SOCIETY FOR METALS — AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS
AMERICAN SOCIETY OF MECHANICAL ENGINEERS — AMERICAN WELDING SOCIETY — THE WIRE ASSOCIATION



Can Handle Wide Range of Work.

from 2 to 24 in. in radius. The apparatus can carry from 2 to 5 torches to perform multiple-cutting operations. The speed range is from 1½ to 75 in. per minute. Duplicate controls enables operation from either the torch or the tracing position, and the machine is said to show a high degree of accuracy in its operation.

Nozzle Makes Fire Fighting Foam With Hydrant Water

A new method of making foam for fire-fighting is announced by the Pyrene Manufacturing Co., Newark, N. J., which has placed on the market the Phomaire Play Pipe, a patented nozzle which mixes ordinary hydrant water with air and Phomaide, a new foam-making solution, and sprays the resulting foam wherever desired. The manufacturers declare the apparatus can be operated by one man, and that it has already aroused much interest among fire-prevention authorities.

New Type of Fuse Plug Never Burns Out

A permanent fuse plug of new design, known as the Perma-Fuse, requires no parts to renew when it goes "off." The fuse contains a little mercury, and the heat from any short-circuit or overload causes the mercury to expand and break the circuit. To renew the fuse, all that is necessary is to unscrew the plug and swing it, contact end down, like a thermometer. This action returns the mercury to the two contact points within the fuse, and the fuse is then ready for reuse. The Perma-Fuse Corp., Louisville, Ky., are the makers.

"Orthosil" Is New Alkaline Heavy-Duty Metal Cleaner

A new alkaline detergent for heavy-duty cleaning operations, known as "Orthosil," has been placed on the market by the Pennsylvania Salt Mfg. Co., Philadelphia, Pa. It is intended particularly for preparing ferrous metals preparatory to welding, painting, plating and vitreous enameling. According to the manufacturers, Orthosil solutions have a high dissolving power on grease and dirt, and can hold such "soil" in suspension after removing them from the metal, thus preventing them from being redeposited on cleaned material. Orthosil is shipped in large drums in the form of dry white, free-flowing granules readily soluble in hot or cold water.

Trade Literature

Much interesting and useful information regarding fuel gases is contained in a pamphlet entitled "Airco Acetylene," issued by the Air Reduction Co., of New York City. The booklet discusses oxy-flame temperatures produced with acetylene, propane, natural and city gases, heating efficiencies, B.T.U. values, oxygen consumptions, comparative oxygen-fuel-gas requirements, and oxy-flame welding and cutting.

"The Properties and Applications of Heat-Treated Wrought Nickel Alloy Steels" has been issued as Bulletin P-1 of the Nickel Alloy Steel series by the International Nickel Co., of New York City. This 14-page booklet contains many interesting discussions of the characteristics of nickel steels, as well as photographs and charts describing their mechanical properties.

Selection of electrodes for welding austenitic manganese steel, selecting and using hard-surfacing welding rod, and test results of hard-surfacing welds, are among the topics discussed in the August, 1936, issue of The Amsco Bulletin, issued by the American Manganese Steel Co., Chicago Heights, Ill.

A wear-resistant, corrosion-resistant, non-oxidizing alloy, known as Colmonoy No. 6, is described, its properties listed, and its application by the gas and are welding processes described, in a folder issued by the Colmonoy Co., Los Nietos, Calif. Colmonoy castings also are described, and the advantages of adding the alloy to copper are discussed.

An eight-page leaflet entitled "Nickel in Your Business" has been published by the International Nickel Co., Inc., 67 Wall St., New York City, there being listed in it a large number of publications bearing upon the application of nickel to the industrial, transportation, and metallurgical fields, all of which publications are offered free.

Catalog No. 333-B has been issued by the Imperial Brass Manufacturing Co., 1200 W. Harrison St., Chicago, describing its complete line of welding, cutting, brazing and lead-burning equipment.

A scaling tool for chipping, peening and removing flux from welds, is described in a leaflet, known as Bulletin 2235-A, issued by The Dallett Co., 165 Clearfield St., Philadelphia, Pa.

Commercial News

Delivers Gases in Trailer to Warehouse Points

The accompanying illustration shows a custom-built semi-trailer which the Commercial Gas Co., 2619-33 Fourth St., Minneapolis, Minn., uses for the delivery of oxygen and acetylene to warehouse points throughout the Northwest.

The trailer has a pay-load carrying capacity of 24,000 lb. and is equipped with such devices as a dual-ratio rear axle with eight forward and two reverse speeds, the latest type of air brakes, a radio, and other refinements.

Steel, aluminum and oak are the materials from which the trailer is made, and welding has been employed wherever possible.

Commercial Gas Co.'s Custom Built Semi-Trailer.

"USS Carilloy" Designates All Steels by Carnegie-Illinois

Announcement of the new trade name "USS CARILLOY" to identify alloy steels produced by the Carnegie-Illinois

el Corp. has been made by this sub-
iary of United States Steel Corp.
It is emphasized in the announcement
t the new name "USS CARILLOY"
es not signify a new product, nor does
pply to any single alloy steel. It is
ply a new trade designation which
l serve as a quality trademark for the
re group of well-known alloy steels
viously marketed as "Carnegie-Illi-
s Alloy Steels."
dvertisements in current trade pub-
tions feature "USS CARILLOY,"
ch is reproduced in a distinctive
d-lettered logotype that makes the
name a trademark as well as a
duct brand name.

is Heads Pittsburgh sting Laboratory

A. R. Ellis, former vice-president of Pittsburgh Testing Laboratory, Pitts-gh, Pa., has been elected president of company, succeeding B. H. Wither-on, who recently accepted an execu-position with the American Optical , of Southbridge, Mass. Mr. Ellis, a ve of Pittsburgh, became affiliated h the Pittsburgh Testing Laboratory lowing his graduation from Cornell iversity in 1905 with the degree of l engineer. He first served as a lab-tory technician, later becoming an pector of engineering materials. In 0 he became chief engineer.
Seven years later, Mr. Ellis was named nager of the New York branch and 1918 was made assistant general man-r. He was chosen general manager director in 1921, becoming vice-sident and director in 1929. Mr. therspoon remains a director of the oratory.

E. Buckingham has been elected e-president in charge of sales for the tern district, by The Lincoln Electric lway Sales Co., Cleveland, O. Mr. ckingham's headquarters will be in Straus Building, 310 S. Michigan d, Chicago, Ill. In 1900 Mr. Buck-ham entered the railroad field, be-ing associated with The Union ific System. Later he was master hanic for the Union Stock Yards Co., owed by his selection as superin-dent of the motor and refrigerator sion of the Wells Fargo Express, service with the Baldwin Locomo-Works and in the railroad depart-ts of the Standard Steel Co. and ociated Oil Co. For the past 14 years as been with The Worthington Pump Machinery Corp., serving five years as tern regional manager of their rail-d division.

Harold K. Work has been appointed tor of research and development of Jones & Laughlin Steel Corp., Pitts-gh, Pa. In addition to directing the ent research staff, Mr. Work will have charge of the new miniature steel plant designed to correlate the work of the research and development engineers with the manufacturing operations. Before coming to Jones & Laughlin, Mr. Work was with the Aluminum Co. of America, having started in their research department in 1929 at their Buffalo, N. Y. plant. In 1931 he was made head of the electro-chemical division of the aluminum research laboratories at New Kensington, Pa., and in 1934 chemical engineer of the jobbing division.

Several conferences have been held in recent months by Westinghouse distributors to keep operators informed regarding late welding developments. Typical of these was the conference held by the Mo-Ark Oxygen Co. and the Westinghouse Electric & Manufacturing Co. in El Dorado, Ark. Here there were demonstrations of d.c. welding generators, cast-iron welding with oxyacetylene, etc. Demonstrations were given in the afternoon and lectures in the evening.

G. Donald Spackman has been appointed general superintendent of the Lukens Steel Co., Coatesville, Pa., to succeed J. H. McElhinney, resigned. The presidency of Lukenweld, Inc., a division of Lukens Steel Co., which position was held by Mr. Spackman, will be filled by Everett Chapman, formerly vice-president, and Robert J. Whiting,

For Strength and Toughness

RYERSON No. 217 WELDING ELECTRODES

(Shielded Arc Type—Heavy Extruded Coating)

Ryerson No. 217 Electrodes used to Weld Alloy Steel Plates and Alloy Castings in this Scraper

The Continental Wagon Scraper, illustrated above, was constructed of alloy steel plate and alloy steel castings electrically welded—a remarkable stride forward in welded design. For High Tensile, ductile welds that will stand the rough going—shocks and strains, the builders (Continental Roll and Steel Foundry Co.) chose Ryerson shielded arc electrode No. 217. It produces a sound weld free from oxides and nitrides and is especially recommended for work where poor fit-up is encountered. Let us give you complete information on this and other outstanding Ryerson welding rods. We will also be glad to send samples for test. Address the nearest Ryerson plant.

Joseph T. Ryerson & Son, Inc., Chicago, Milwaukee, St. Louis, Cleveland, Cincinnati, Detroit, Boston, Buffalo, Philadelphia, Jersey City

RYERSON

formerly superintendent, has been made vice-president to fill the position vacated by Mr. Chapman.

Distribution of "Meco" oxyacetylene welding and cutting equipment is to be handled in the Portland, Ore., territory by Davis & Kullberg, located at 401 N. W. 6th St., and in the Peoria, Ill., territory by the Peoria Welding Supply Co., 529 S. Adams St., it is announced by the Modern Engineering Co., St. Louis, Mo. M. J. Callahan, long associated with the gas-welding industry, is manager of the Peoria company.

Word has been received by the Will-Weld Manufacturing Co., Inc., Omaha, Nebr., from the Underwriters' Laboratories announcing approval of the Will-Weld Model S-1, types 100, 175 and 225, arc-welding machines, and a report recommending listing has been prepared. Underwriters' approved models will be announced soon, says D. G. Dayton, Will-Weld sales manager.

Announcement has been made of the appointment of Stephen M. Jenks as chief engineer of the new construction engineering division of the Carnegie-Illinois Steel Corp., Pittsburgh, Pa. Mr. Jenks entered the employ of the United States Steel Corp. in 1925 and has been advanced rapidly in the engineering division.

The Will-Weld Manufacturing Co., Omaha, Nebr., has opened new sales outlets in Canada, Mexico and South America, and negotiations are in progress for the establishment of distributors in Japan and England, according to L. O. Schneiderwind.

Lorn Campbell, Jr., president of Harris Calorific Co., Cleveland, O., was married in Lakewood, a suburb of Cleveland, on Aug. 29. Immediately after the wedding, Mr. and Mrs. Campbell departed for a honeymoon trip, and will be gone until Oct. 1.

Frederick S. Cook has been appointed Pacific Coast manager for the Robert W. Hunt Co., with headquarters at San Francisco. Mr. Cook was for many years vice-president and secretary of the McCracken-Ripley Co., of Portland, Ore.

Hoyle Jones, until recently president of the Superior Tube Co., has been appointed sales manager of the Tulsa, Okla., district of the Republic Steel Corp., to fill the vacancy created by the recent death of C. S. Powers.

The Reid Avery Co. announces the removal of its general offices from Philadelphia, Pa., to Dundalk, Baltimore, Md., the move being made in order to locate this department adjacent to their factory.

R. D. Thomas, vice-president of Arcos, Inc., Philadelphia, Pa., has returned from a 6-weeks' trip to Europe, where he investigated the latest European practices in alloy and non-ferrous arc-welding electrodes.

The general office of Wilson Welder & Metals Co., Inc., has been moved from North Bergen, N. J., to 60 East 42nd St., New York, N. Y.

Davis & Kullberg, 401 N. W. 6th Ave., Portland, Ore., have been appointed Westinghouse welding distributors for the state of Oregon.

Notes From the Field

The American Bridge Co., of Pittsburgh, Pa., was low bidder for the construction and delivery of three welded steel dump scows for service on the Ohio River, when bids were opened recently by the U. S. Engineers at Louisville. The company, a United States Steel subsidiary, submitted a bid of $53,820. Ten bids in all were received, among them the Treadwell Construction Co., Midland, Pa., $74,100; Bethlehem Steel Co., Pittsburgh, Pa., $64,950; Dravo Contracting Co., Pittsburgh, Pa., $77,400; and Marietta Manufacturing Co., Point Pleasant, W. Va., $94,000. The scows will have a capacity of 280 cu. yd. each. Delivery is to be made in 210 days.

What is considered an innovation in delivering boats will be accomplished by the Howard Shipbuilding Co., of Jeffersonville, Ind., at an early date, according to Mrs. Loretta Howard, treasurer of that company. There are now under construction in their yards two utility cruisers for the forestry division of the TVA for service on Norris Lake. These cruisers, each 62 ft. long, of the welded type, will be shipped in halves on four railroad cars to Norris Lake, where the halves will be welded together and launched. Delivery is to be made Oct. 1. They are equipped with Diesel engines and cabin with seats for 25 passengers.

A contract to furnish 70 pieces of electric-welded steel pipe to be used in the construction of a fleet of 24 riveted steel pontoons for use by the U. S. Army Engineers of the St. Paul district, has been awarded the Treadwell Construction Co., of Midland, Pa. The price submitted was $72,290. The other bidders were: Ingalls Iron Works, Birmingham, Ala., $79,140; Bethlehem Steel Co., Bethlehem, Pa., $83,958; and Charles Hegewald, New Albany, Ind., $75,782. The Government estimate was $65,931. The pipe will be 20 in. inside diameter, in 18-ft. sections, and will be used in connection with two suction dredges.

The plant equipment of the Alloy Welding & Manufacturing Co., 1113 Metropolitan St., Pittsburgh, Pa., was sold Sept. 9 by David L. Starr, Pittsburgh attorney and receiver, to the Reliance Machinery Co., also of Pittsburgh, for $2,538. The equipment included several lathes and miscellaneous welding equipment. The Alloy company suffered heavily as a result of the St. Patrick's Day flood and the plant had never been rehabilitated following that disaster. Mr. Starr was appointed receiver for the company by the Federal Court at Pittsburgh when the company failed to meet its obligations.

Engineers of the Louisville district opened bids in their offices recently for the construction and delivery of a total of 4,700 ft. of welded discharge and shore pipe, to be used by the U. S. dredge, *C. B. Harris*, in channel work on the lower Ohio River. A total of eight bids were submitted. The Bethlehem Steel Co. submitted a high bid of $27,408, with delivery at its Leetsdale, Pa., plant. The Treadwell Construction Co. submitted a low figure of $21,226, with delivery at its plant at Midland, Pa., and an alternate bid was given for $21,139, delivered afloat at Paducah, Ky.

Eight of the principal barge- and boat-building firms throughout the eastern part of the United States have submitted bids to the marine division of the Gulf Refining Co. for the construction of two all-welded steel barges to cost approximately $55,000 each, preliminary details of which appeared in the August issue of *The Welding Engineer*. No award has as yet been made but prices were taken on lots of one and two barges, each of varying dimensions. The barges will be operated on the Ohio River and other inland waterways.

The Jones & Laughlin Steel Corp., Pittsburgh, Pa., is adding to its already large fleet of river transportation equipment, for the movement of steel products. At the present time the corporation is constructing a fleet of 10 all-welded steel barges, of the covered cargo type, for down-river service. These barges, each 132 ft. long, will require a total of 2,180 tons of plates and shapes. This is the first all-welded equipment to

be built by the corporation, and will augment the corporation's present fleet of 40 riveted barges.

The Patterson Oil Terminals Corp., Philadelphia, Pa., has awarded a contract to the Dravo Contracting Co. for the construction of a steel tank barge for coastwise petroleum-products service. It will be 110 ft. long, 80 ft. wide, and 11 ft. deep, with 10 compartments, and will have a capacity of 200,000 gallons. Material for this carrier will be fabricated in the Neville Island yards and shipped to Wilmington, Del., where it will be assembled and launched. Delivery is expected to be made about Oct. 1.

A large bucket used in a rock quarry at Pontiac, Ill., has been brought to The Superior Welding Co., Peoria, Ill., for repairs. A large manganese casting in the bottom was broken almost in half and another at the top was broken in one large corner section. By means of bolts and clamps these castings were pulled back into place and welded. New rivets were driven and the plates were reinforced with 1x6-in. bars. New bushings were welded in and the teeth were repointed and hard-surfaced.

Hollow rib steel roofing has been laid and welded on one of the new buildings at The Caterpillar Tractor Co. foundry. The roof is 360 ft. long and 80 ft. wide. Another new building, in the tractor division, is two blocks long and about 40 ft. wide. Laying and welding this roof has now started. The Fenestra Construction Co., of Chicago, has the contract for laying these roofs, and The Superior Welding Co., of Peoria, are furnishing equipment and an operator.

The Jones and Laughlin Steel Corp., Pittsburgh, Pa., has completed the construction of a welded tank barge for the Producers Pipe Line Co., Inc., of Owensboro, Ky. It is 165 ft. long, 35 ft. wide and 10 ft. deep and required approximately 185 tons of steel plate and shapes. The barge was equipped with pipes, and the Producers company will install additional pipes and pumps. The barge will be used in inland-waterway service.

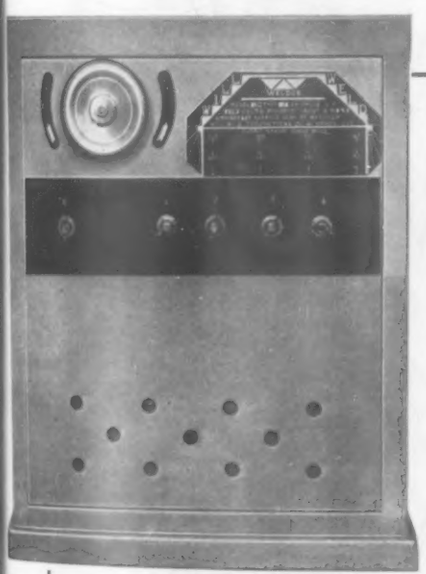
Forming one of the most complete and modern gas-welding laboratories in the Pacific Northwest for the instruction of students, upwards of $1,500 of new equipment for oxyacetylene welding and cutting has been placed at the disposal of the Washington State College at Pullman, Wash., by the Union Carbide and Carbon Corp., according to Prof. G. E. Thornton, of the College of Engineering and Mechanical Arts.

W. I. Brockson has been elected vice-president of the Commercial Advertising Agency, Chicago, Ill., which firm he joined two and a half years ago as an account executive after having served nine years as advertising and sales promotion manager of the Steel Sales Corp., Chicago. Mr. Brockson has contributed many articles on the management of welding shops to *The Welding Engineer*.

U. S. Army Engineers of the Louisville, Ky. district are taking bids for the construction of a total of 4,690 linear feet of electrically welded dredge pipe. This equipment will be used for suction dredges on the lower Ohio River. Bids are also being taken to furnish 60 60-ft. sections of discharge pipe and 72 15-ft. 2-in. sections of shore pipe, all pipe to have an inside diameter of 24 in.

The Ohio River Co. of Cincinnati, O., has placed a contract with the Stanwood Co., of Covington, Ky., for the construction of five all-welded coal barges. These barges will be used for the coal trade on the Illinois River. Each will be 195 ft. long, 35 ft. wide and 11 ft. deep, with a capacity of 1,250 tons each. About 220 tons of steel plates and shapes will be required for their construction.

The Western Gas Co., of El Paso, Texas, will start work this month on the



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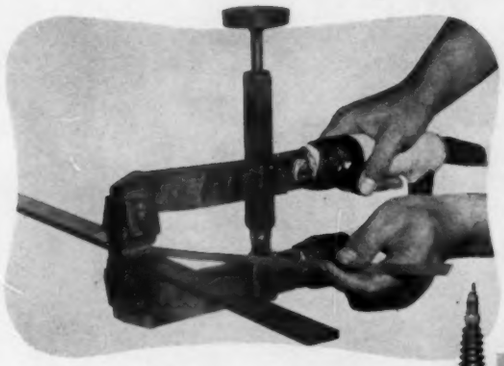
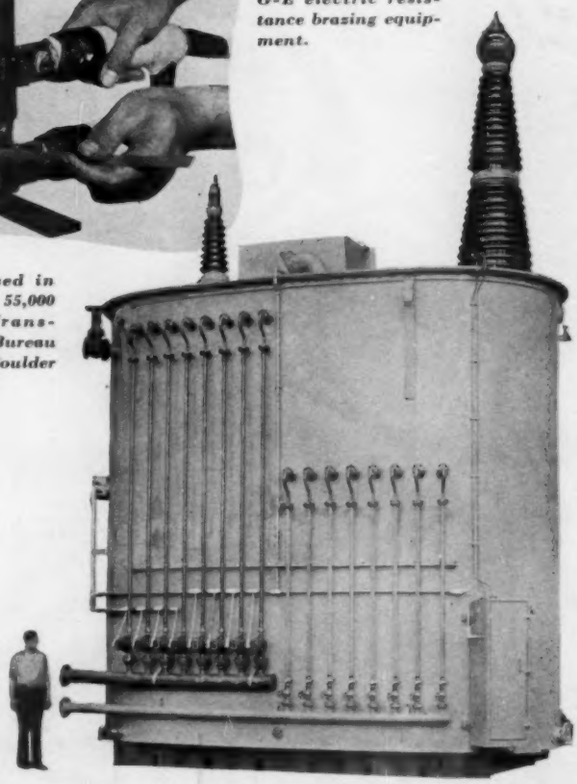


Joining copper bars with SIL-FOS and G-E electric resistance brazing equipment.



SIL-FOS was used in making this G-E 55,000 K V A Power Transformer for U. S. Bureau of Reclamation, Boulder City, Nevada.

When a product meets every requirement in any particular kind of work, it is bound to win general acceptance.

SIL-FOS, the low temperature brazing alloy does just this in joining non-ferrous metals for many purposes. This fact is well demonstrated by its use on electrical equipment.

The General Electric Company use SIL-FOS in constructing their various sizes of transformers, large and small. They braze taps on coil conductors and join copper bars. On this work, SIL-FOS has made *over 3,000,000 joints without a failure.*

SIL-FOS gives this reliable service because the joints it makes at low temperature (1300° F.) are strong and ductile—it actually alloys with the metals joined making them one solid piece highly resistant to severe shock, constant vibration and wide temperature changes. A joint which gives high conductivity—and due to the small amount of SIL-FOS required does the job at low cost.

Try SIL-FOS on your work.

Use it with our low temperature HANDY-FLUX.
Write us for Bulletin 59W and our recommendations.

HANDY AND HARMAN
82 Fulton St., New York

construction of an 80-mile welded gas line from its main Phoenix line between Casa Grande and Coolidge, to extend to Ajo, Ariz., for serving the Phelps Dodge Corp., owners of the New Cornelia mine. It is said that this mine will use more gas in the treating of its ore than the entire city of El Paso.

The Cotton Factory Hollow bridge, in Schenectady, N. Y., was recently condemned because of deterioration of the steel girders. An examination of the bridge was made by engineers, and it was decided that welding would remedy the trouble. Contract for the welding was awarded the Friedman Welding Service, of 15 Doggett Terrace, Schenectady.

Frank Cordes, who has been senior vice-president of the Blaw-Knox Co, has been elected president of the company to fill the vacancy caused by the death of Irvin F. Lehman. Chester H. Lehman was elected senior vice-president and George L. Dumbauld, treasurer, was also made a vice-president. All the other offices of the company remain the same.

Welding will play an important part in the early construction of the largest dry-ice-manufacturing plant in the world, which is to be built at Bueyeros, N. M. Natural carbon-dioxide gas for the processing of dry-ice will come from wells near there, one of which recently made a test flow of 3,500,000 cu. ft. daily.

The Union Barge Line, Pittsburgh, Pa., has awarded a contract to the Dravo Contracting Co., also of Pittsburgh, for the construction of a fleet of four all-welded steel barges. These new barges, with a capacity of 1,000 tons each, are being added for the movement of freight from the Pittsburgh harbor to Southern ports.

A new rackhouse at Hiram Walker's Distillery, Peoria, Ill., will soon be ready for the steel roof, which is to be laid by The Fenestra Construction Co., of Chicago. It will be tack welded the same as all steel roofing laid by this company, with welding equipment furnished by The Superior Welding Co., of Peoria.

A $250,000 pipeline order has been received by the Republic Steel Corp., Cleveland, O., from the Penn-York Natural Gas Co. for 60 miles of 10¾-in. electric-welded pipe, to be used in a new natural-gas line running from Coudersport, Pa., to Batavia and Dunkirk, N. Y. The order involves 3,326 tons.

The United States engineers office for the Pittsburgh district has been requested by the 2nd New Orleans District

o conduct inspection on 936,000 sq. ft. f welded wire fabric for the Keystone Steel & Wire Co. Fabrication will be ade by the Pittsburgh Steel Co. at its onessen, Pa., works.

A large blending and storage plant is nder construction by the Sun Oil Co., n Los Angeles, Calif., on a site between 6th St. and Washington Blvd., near Alameda and the Santa Fe tracks. Weldng will be used extensively in the buildng and installation of the tanks, piping, c.

The Dravo Contracting Co., of Pittsburgh, Pa., has received a contract to uild an all-welded oil barge for Patterson Oil Terminals, Inc., of Philadelphia. Delivery is to be made in October. The arge will be 110 ft. long, 30 ft. wide nd 11 ft. deep, with a gross tonnage of 35.

Authorization to construct 100 additional tank-car tanks by the fusion-welding process for experimental service in the transportation of butane and ropane, was recently granted the Union Tank Car Co. by the Interstate Commerce Commission, it is reported.

The Cottage Grove Welding Works, Cottage Grove, Ore., recently built a 50x50-ft. shop building, with overhead rane and jib crane to serve the welding benches. A large preheating oven is ow in the course of construction.

A virtually tropical downpour occurred efore meeting time, causing only a few embers to be present for the scheduled eeting of the Greater Cincinnati Weldrs Association, on Sept. 2. The meetng was postponed to Sept. 16.

Increased activity on the part of rucking lines during the last few months as contributed materially to the 50% etter business compared with this time year ago, says H. H. Donahue, welder, f Tulsa, Okla.

The Nebraska Blacksmiths and Weldrs Association will hold their annual onvention at the Rome Hotel, Omaha, ebr., on Oct. 29-31. A number of weldng supply firms will have exhibits and emonstrations.

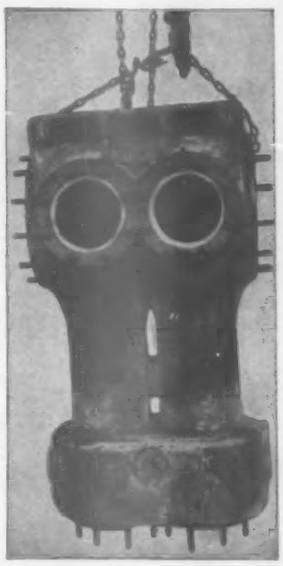
L. C. Brown, of Brown's Welding orks, 2425 East 54th St., Huntington ark, Calif., is erecting a new building t 2434 East 54th St., into which he ill soon move his shop.

Work of remodeling and enlarging is nder way at the Economy Welding ervice, 1723 Cumings St., Omaha, ebr., to make more room for their elding and "metallizing" operations,

PREHEATING

The great aid to good welding and brazing—economically and efficiently done, with TORIT Air-Oil Burners.

These Burners are so easily operated, and they save so much expense, that they are in constant use in Welding Shops everywhere.



This pump casting weighing 1800 pounds was brazed with two welding torches assisted by two TORIT Preheaters.

The job was not only *Well Done*, but it was done in the least possible time, and with the lowest possible expense.

Jobs of this kind quickly pay for a TORIT.

TORIT Air-Oil Burners for Heat!

Besides being used for preheating, these burners are excellent for heating pipe, beams and bars, for bending or straightening; for melting lead, solder and babbitt; for heating tar, asphalt and pitch; for weed burning; for thawing, and for all kinds of work requiring a large hot flame.

TORIT Air-Oil Burner No. 8-K

A hand-pump portable outfit with 10 gallon tank. F. O. B. St. Paul, $66.00.

Ask for full information on the popular No. 8-K and other types and sizes.

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according to L. B. Thomas, proprietor of the company. The Economy Welding Service has just finished a large bridge overpass job for the Geo. W. Conlin Co., who erected the bridge at St. Charles, Mo.

P. H. Gagnon has retired as welding instructor at Dunwoody Institute, Minneapolis, Minn.

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Help Wanted—75c per line, minimum 4 lines. Jobs Wanted—4 lines free. Other Ads—$1.00 per line, minimum 4 lines. Count 8 words to line. Add 6 words for keyed address.

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WELDIT, 638 Bagley, Detroit, Mich.

For Sale—Metal Spray and Sandblast Equipment, consisting of Curtis 6x6 duplex compressor, MacLeod 600-lb. sand mixer, dust collector and air tank. Earl Tupes, 535 Peck St., Muskegon Heights, Mich.

Arc Welders—200 and 300 ampere Lincoln, both a.c. and d.c. motor drive. Many others in stock. Goodman Electric Machinery Co., 1060 Broad St., Newark, N. J.

Fly Ball Governors—Adapted to all makes of auto engines; belt driven, flat or V. Price, $6.50 prepaid. Satisfaction guaranteed. In ordering state style of belt. Wm. D. Alber, Beatrice, Nebr.

Bargains—Demonstrator Arc Welders. Gasoline and electric drive. 30 days' trial. Easy terms if desired. Write Ken's Exchange, Box U-861, Troy, Ohio.

WANTED TO BUY

WANTED—200-AMP. GENERATOR COMPLETE

Late model. Give full description and price. Charles Dean, Ft. Myers, Fla.

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For A.C. Transformer Welders—EASYWELD ELECTRODES! EASYWELD starts arc quickly, holds it easily. Ideal for light-gauge steel welding, for repairs on steel, iron. High tensile strength. Sizes: 1/16 in., 3/32 in., 1/8 in., 5/32 in. Send for prices, samples moderate charge. Universal Power Corporation, Dept. 310, 4300 Euclid Ave., Cleveland, O.

Arc Welders—Build Your Own, saving $300 to $500. Complete instructions furnished. Easy pays-its-own-way terms. Investigate before you buy any welder. Hobart Welder Sales, Box U-462, Troy, Ohio.

HELP WANTED

Wanted—Electric welders qualified for fabrication of API ASME Code vessels. Excellent working conditions steady work. Include references and record of experience with application. Address S-1, The Welding Engineer.

POSITIONS WANTED

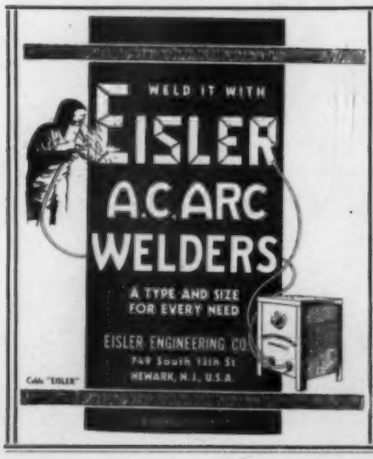
Foreman or Supervisor—Formerly assistant supervisor U. S. Government work. Qualified U. S. Navy and A.S.T. tests. 14 years' unlimited experience in repair and production work, shielded arc, bare electrodes, alloys, castings, high pressure vessels, shipyard work, both gas and electric. Experienced in the handling of men. Knowledge of welding practical and theoretical. 30 years of age. L. W. Payne, 103 Fourth Ave., Newark, N. J.

Job-Shop Welder—4 years' experience with both arc and gas. 25 years old. High-school education, single. Would like to travel with construction company. Will go anywhere. Max Fay, care of Halls Welding Shop, 203 Homewild Ave., Jackson, Mich.

Arc Welder—Graduate of welding course at Milwaukee School of Engineering. Three years' experience as welder helper. 23 years old. Willing to travel anywhere, including foreign service. Donald M. Lane, 610 E. Juneau Ave., Milwaukee, Wis.

Combination Welder—Experience dates back to 1918. Experience in job-shop work and in salvage department of manufacturing plant. Both ferrous and non-ferrous metals and alloys. M. W. Donarski, 2241 W. Cortland St., Chicago, Ill.

Combination Welder—Experienced in arc and gas, also machinist. Young, dependable, will go any place. Clinton Loos, 302 Commercial St., Charleston, Mo.



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